POWER PLANT ENGINEERING

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Where Power Is By-Product

LIQUID CARBONIC CO. BURNS COKE TO SECURE HIGH CO_2 PERCENTAGE AND DEVELOPS SUFFICIENT POWER TO OPERATE ALL MACHINERY

BY PROPER SELECTION and proportioning of equipment, and careful operation, the new carbonic acid gas plant of the Liquid Carbonic Co., in Chicago, is capable of furnishing just sufficient power to operate all its pumps and compressors necessary for absorbing, compressing and condensing the CO_2 developed in the furnace. In this plant two problems of considerable interest to power plant engineers have been solved. These are, first, the burning of coke to secure a continuous high percentage of CO_2, and, second, the adaptation of the engine to a load divided between a direct connected air compressor and a belted line shaft.

In order that these problems may be appreciated an outline of the process of making liquid carbon dioxide will be given. The carbon dioxide is formed by combustion in the boiler furnace, from which the gaseous products of combustion of the coke pass through the boiler and economizer, then to scrubbers that take out dirt and gases formed from sulphur. From the scrubbers the gases pass to a rotary blower, which forces

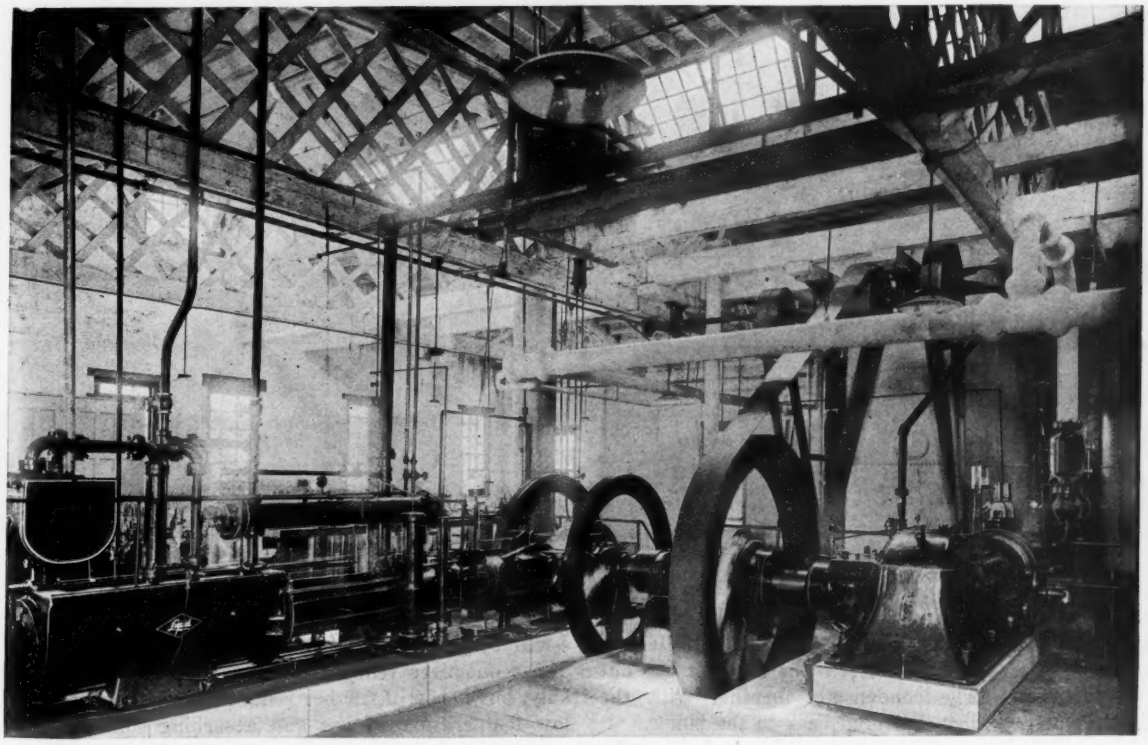


FIG. 1. VIEW IN ENGINE ROOM OF LIQUID CARBONIC CO.

them through absorbers containing a solution of lye, the unabsorbed gases, principally nitrogen with a small percentage of oxygen, and unabsorbed carbon dioxide, passing to atmosphere. The lye solution containing the absorbed CO_2 then passes through a heat exchanger, where its temperature is raised to some extent, then goes through the waste heat economizer to the steam condenser, which raises its temperature to a point where it gives off the CO_2 gas, which is compressed and condensed to a liquid and delivered to cylinders for shipment. The lye solution, after giving up the carbonic gas, passes through the other side of the heat exchanger back to the absorbing system, ready to repeat the cycle.

induced draft is maintained over the fire, and the rate of combustion averages about 10 lb. per sq. ft. per hr. The product desired from the coke is primarily carbonic gas, CO_2, with heat as a by-product to furnish steam for power. With this end in view, the process is so controlled as to secure a flue gas containing 17 to 19 per cent CO_2.

To aid the fireman in maintaining proper conditions a Uehling indicating and recording CO_2 machine is provided, also Ellison differential compound draft gages.

When the fires are first started the draft is given by a small stack until steam pressure is raised, then they are drawn first through an economizer located directly

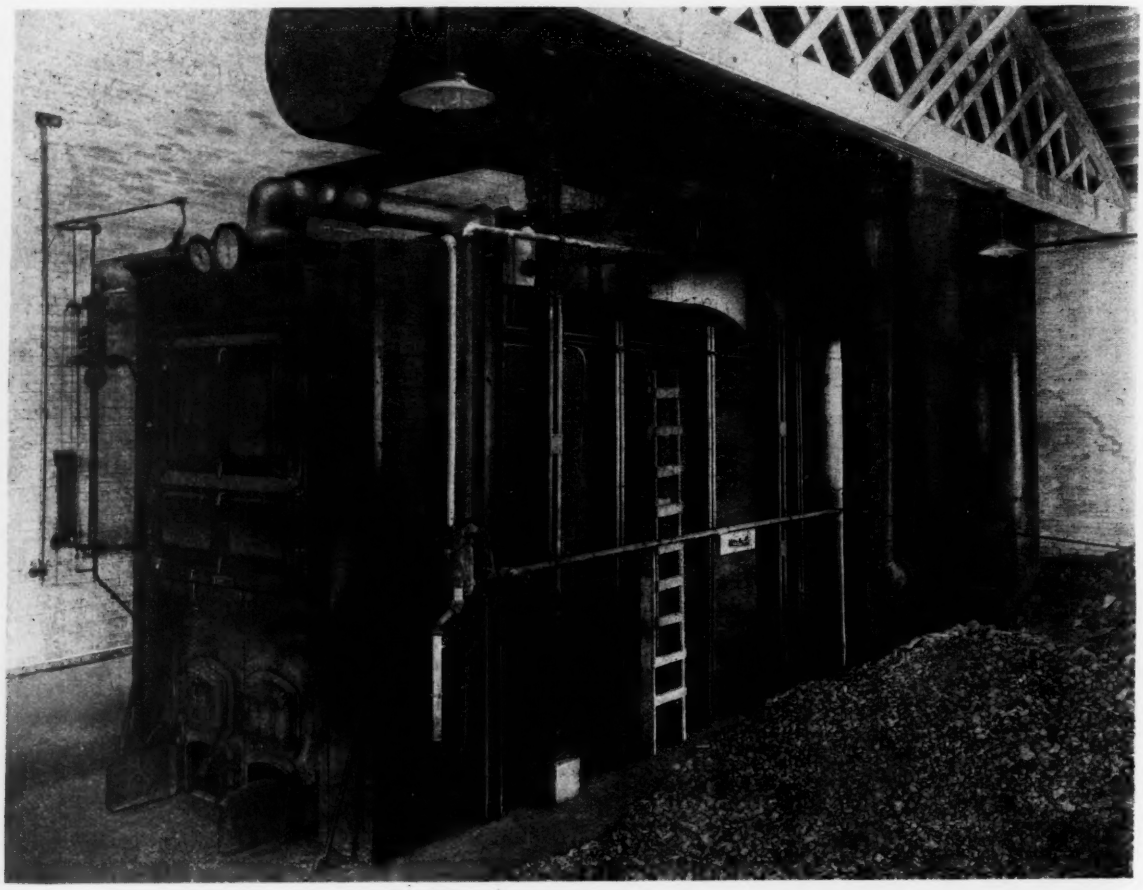


FIG. 2. BOILER WITH FURNACE FOR BURNING COKE, ECONOMIZER ABOVE AND SCRUBBERS AT THE REAR

Steam takes the usual course through the engine, but exhausts against a pressure of from 10 to 15 lb. into the condenser or boiler that drives the carbonic gas out of the solution. The condensate, together with the make-up water, is then delivered back to the boiler.

In the boiler room is one 200-hp. Kroeschell combination fire and water tube boiler, which is operated at 140 lb. steam pressure. It is equipped with shaking grates on which coke, either by-product or foundry, is burned. The fuel bed is maintained at 8 to 12 in. thick, and the alternate system of firing is employed. A low

over the boiler and then through two scrubbers in series by a belt-driven Roots rotary pressure blower. The economizer reduces the gas temperature considerably, but it is still further reduced by the scrubbers. A low temperature of gas and absorbing solution is desirable for most rapid absorption of the carbonic gas, while the solution must be boiled under proper pressure to drive off the carbonic gas, so the process is one of alternately heating and cooling the lye solution, the boiler furnishing all the heat necessary for the process and steam required for power.

All steam developed is used first for driving a Lentz engine, the special features of which will be described later. The load carried is about evenly divided between a three-stage direct connected gas compressor and a belt-driven line shaft. The compressor was manufactured by the Laidlaw-Dunn-Gordon Co., and is of special design, with an 18-in. stroke, and delivers the gas at

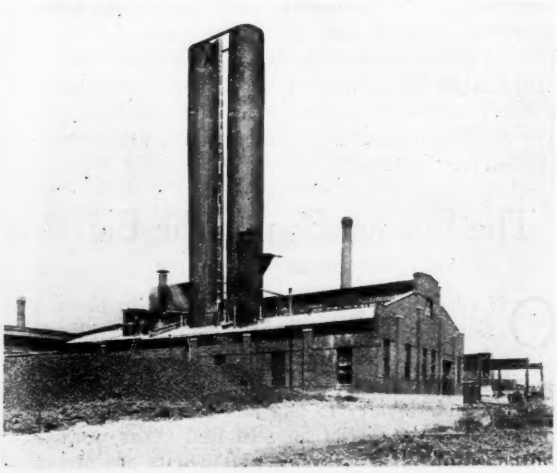


FIG. 3. EXTERIOR VIEW OF CARBONIC PLANT. TWO LARGE STACKS AT CENTER ARE ABSORBERS, IN FRONT AT THE RIGHT THE CONDENSER, SMALL STACK WITH HOOD IN FRONT OF COOLING TOWER IS STARTING SMOKE STACK

1000 lb. pressure. Two intercoolers keep the temperature down during compression and an aftercooler condenses the gas to a liquid, in which form it is bottled up for shipment in steel cylinders. To drive the compressor requires about 60 hp.

Power transmitted by the belt to the line shaft is also about 60 hp., being used to drive one Goulds triplex pump for circulating the lye solution through the boiling-off system, two centrifugal pumps for circulating the lye solution within the absorbers, the Roots rotary blower for handling the gaseous products of combustion, and a Goulds triplex boiler feed pump.

Adapting Engine to Conditions

To secure a balance of conditions between carbonic gas produced and power required to operate the plant, it was recognized that an engine of high steam economy was required. Experience of the company in other plants with the Lentz engine, manufactured by the Erie City Iron Works, led to the choice of a similar engine in this plant. Owing, however, to war conditions, it was found necessary to adapt an engine designed to

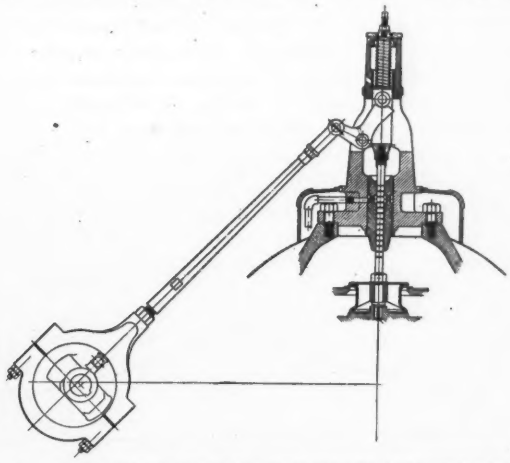


FIG. 4. SECTIONAL ELEVATION OF ENGINE ADMISSION VALVE SHOWING CONSTRUCTION DETAILS

operate at 200 r.p.m. for direct connection to the compressor, which runs at 110 r.p.m. The necessary changes consisted merely in adjusting the governor by means of spring tension and weights and providing a flywheel of proper size and weight, 11,000 lb.

This engine is 15 by 21 in. and runs at 110 r.p.m. under steam pressure of 140 lb.; its rating is 106 i.hp. when run with 2 lb. back pressure with a maximum rating of 171 i.hp. Such a change from high to low

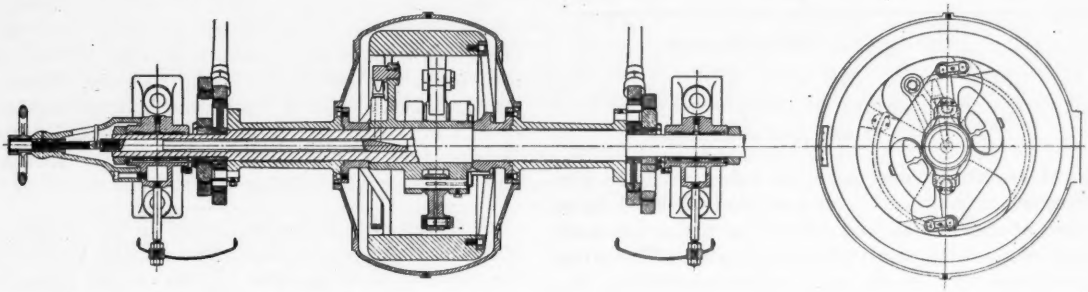


FIG. 5. AXIAL AND TRANSVERSE SECTIONS OF ENGINE GOVERNOR

speed is not uncommon with this type of engine, as the valve mechanism is well adapted to either high or low speed; consideration, however, must be given to the load carried under the different conditions. Tests have shown that with saturated steam the steam economy does not vary more than 5 per cent from 75 to 125 per cent rated load.

The characteristics of the Lentz engine are the valves, valve gear and governor, and these are the features which make possible a wide variation in speed and are largely responsible for high steam economy throughout the range of speed. As will be noted in the sectional elevation, Fig. 4, the steam valves are of the double-seated poppet type, with long spindles ground to fit the bushings without stuffing boxes. Grooves are turned on the spindles to catch and condense all steam that tends to escape, and forms a water packing that is positively steam tight. The valves are moved by cams acting on rollers. When the valve is seated the roller is not in contact with the cam but the clearance is slight. When the valve is off its seat the roller is held in contact with the cam by means of a spring.

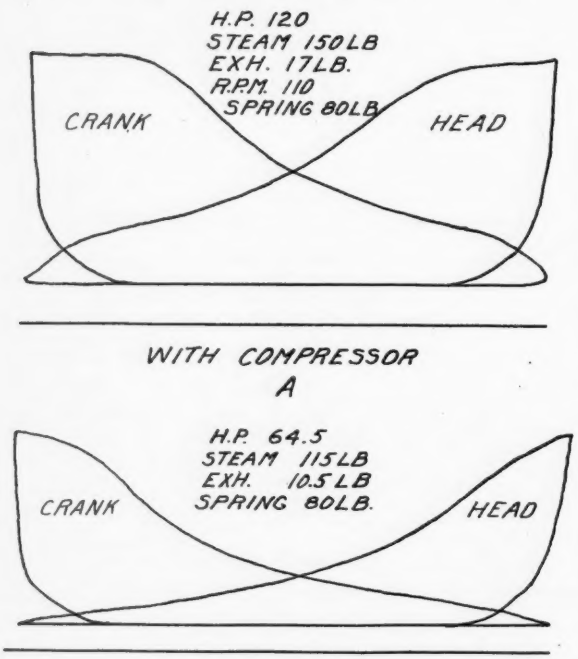


FIG. 6. CARDS FROM ENGINE SHOWING DIVISION OF LOAD BETWEEN LINE SHAFT AND COMPRESSOR

Four eccentrics, one for each valve, and the governor are carried on a horizontal shaft located along the side of the engine and driven by the crank shaft through a specially constructed bevel gear. The eccentric rods are coupled directly to the ends of the cam levers and the throw of the steam eccentrics is regulated by means of a wedge which slides in the shaft, its position being under the control of the governor.

Figure 5 shows the arrangement of the eccentrics and governor on the lay shaft, also a transverse section of the governor which is peculiar to this engine. The governor consists of a heavy inertia ring surrounding the other moving parts of the governor, and two centrifugal weights, which are controlled by a single flat bent spring which can be readily removed or replaced. The action of the governor shifts the wedge longitudinally and so alters the throw of the steam eccentrics. The two weights are pivoted on a carrier keyed to the side shaft. The weights and the carrier are attached by a spring and a knee joint to the inertia ring, which performs the functions of a flywheel. With a slight change of speed, the inertia of the outer ring, which tends to keep its speed constant, causes it to move with relation to the carrier, and moving the eccentrics alters the cutoff to suit the change of load.

The accompanying cards taken recently show steam distribution within the engine while the total plant load is being carried and with the compressor load removed. The cards also show the high back pressure under which the engine operates.

The Foreign-Born in the Big War

By Ernest L. Mandel

ON every battleship and battlefield, in every munition shop and factory, the men of alien birth have fought and worked side by side with our native sons. With their life's blood, these heroes of foreign birth showed their loyalty to flag and land, and paid the supreme price of patriotism. In Red Cross work, in the purchase of Liberty Bonds and Thrift Stamps, in the planting of gardens, in the work on the farm and at the fiery furnace, our alien peoples have responded to the call of the country with a patriotism that may well challenge our own citizenship.

There are some among the men and women of foreign birth, as among the native citizens, who do not yet fully understand the purposes of America. It is the duty of those who do understand to make clear these purposes.

America needs its sons of foreign birth, for this is a land without a king—a great partnership where every citizen is king. We are still in the making, and all willing hands are needed to lay the foundations for the future for the still greater nation that is to be.

America is no longer a land of the past. She is ceasing to be selfish. A new spirit has taken hold of even her selfish men, so that America is today the hope of all mankind. The destiny of Russia, Belgium, Poland, Palestine, Bohemia, Servia, Roumania and the highest destiny of even the Central Powers themselves is at stake. Who is there so dead who does not wish to take a vital part in this world building?

Philadelphia Electric Co. has in view a new power house at Beach and Palmer Sts., to add 90,000 kw. to the capacity of its facilities. Plans call for three 30,000-kw. units, and a loan was asked from the government of $6,000,000 to cover 40 per cent of the cost. Request was first made for $20,000,000 on the basis of assistance to be given to the Emergency Fleet Corp. in supplying power. This was rejected, and negotiations then began for a $15,000,000 plant. It is reported that this was reduced to $6,000,000 as a result of investigations of power conditions in Philadelphia by government engineers. It is now stated that the application has been refused by the United States Shipping Board.

Economics of the Power House

Problem of Power House Accounting Approached from the Point of View of the Economist. By L. W. Alwyn-Schmidt

THE DESIRE for greater economy in power consumption and expenditure has brought to the foreground again the question of more exact power house accounting. Power house owners realize that, before savings can be made, it will at first be necessary to establish exactly which are the factors governing their power expenditure. Only after these are known will it be possible to check the growth on the cost of the individual items. Power house accounting, therefore, must form a very important part of the general science of factory management, and a study of the economics of the power house should be of value to power house engineers and factory owners alike.

The principal trouble is that each of the two is looking at the question from a different point of view. For the power engineer, all power house accounting must be a matter of production; for the manufacturer, it is one of cost. The first considers the expenditure as a means to production, the second as the price of an article of consumption. The engineer wants to know how much it costs him to deliver one horsepower unit, the manufacturer the productive value of each horsepower unit that is produced by his power plant. In principle both aim at the same, but in practice their way of approaching the question must differ essentially. Hence the attempts of power house accounting made by engineers do not satisfy the manufacturer, nor can the former make use of the cost accounting systems prepared by the commercial accountants of the firm. The deduction of the disinterested onlooker naturally must be that each of them will have to please himself and that the two points of view cannot be reconciled.

All forms of cost accounting, to be of value, must lead to somewhere. They should not be only a means of establishing loss or gain, they also must be of such character as to allow an insight into the economic working of the plant. If carried through with this double end in mind, it will be a useful guide to the engineer and management in handling the policies of the firm as to power application and conservation.

Let us consider the problem from the point of view of the power engineer. I am thinking here principally of the man in charge of a steam or gas plant which supplies power to a manufacturing establishment of medium size either by direct transmission or after its conversion into electricity. Such a plant exists as a rule as an individual unit in the general establishment and is carried as such in the books of the enterprise. Little attention need be paid to the fact whether the primary power is used in direct connection with the machine equipment or converted into electrical energy. While the technical management of such a plant may necessitate certain deviations in its system of cost accounting, the principles involved remain the same, and a consideration of these differences can be dispensed with.

Fuel Principal Factor of Varying Cost of Power Production

Fuel is the principal item of recurring cost and coal takes the leading position among the fuels used by the national industry. During the year 1914, 14,724,265 tons of anthracite of 2240 lb. each and 166,699,827 tons of bituminous coal of 2000 lb., 32,539,325 tons of coke, 48,689,232 bbl. of oil and 285,609,876 cu. ft. of gas were consumed as fuel by the industries, not including the coal used for power generation by the electrical central stations. Of the 181,000,000 tons of coal consumed there have to be deducted 50,000,000 tons used by the coke ovens and approximately 20,000,000 tons consumed by other industries for purposes not connected with power generation, which leaves approximately 110,000,000 tons of coal fired under the steam boilers of the industry, a coal consumption of 7¾ tons for each primary horsepower which was generated by steam; no wonder that the varying price of coal is of great influence on the cost of power production.

There are also considerable differences in the quality of coal, which must affect necessarily both the consumption of coal per horsepower unit as well as the price of coal. A power plant using a coal of lower steam value will require a larger quantity of coal than a power house using a better class of coal. On the other hand, there may be considerations of price acting in favor of the use of coal of a lower steam power. To run a plant economically as to coal consumption both in quantity and price, therefore, requires the careful accounting as to the following items: power produced per coal unit, price of coal per horsepower unit produced by the power house. The principal point to be gained is that of cheapest supply of power by best utilization of the existing equipment. If a coal of lower grade is obtainable at a price considerably below that charged for the higher grade coal, the deciding factor must be, which of the two is the cheaper in operation in relation to the results obtainable. An efficiency factor has to be established. In practice it will be found that the efficiency factor will not vary greatly in the long run, especially if the factory lies in a district where no coal is mined. Competition between the coal distributors forces the miners to handle prices according to the local conditions. Coal of lower steam quality is larger in bulk, and more is required to obtain the same result as will be obtained by using coal of higher steam quality. Therefore the consumer has not only to buy a larger quantity of coal, but the transportation charges will be higher, which both act in favor of the coal with the higher steam power.

Natural selection and the desire of the coal distributors to sell creates, therefore, a sort of local efficiency factor for coal which tends to equalize the price between the coal of the higher or lower grade. Even fractional savings, however, are of importance in the

economical running of a power house, and an exact knowledge of the two factors of horsepower production and cost in reference to fuel is absolutely essential. With coal prices frequently changing, the relative value of the fuel for the purposes of the power house is subject to continual changes. A coal price and efficiency analysis based on horsepower production to be of value to the firm, therefore, must be made in frequent intervals, so that it takes in every change of price and steam value and allows a clear view of this part of the power cost.

Present-day conditions are not favorable to the economic running of power plants, and many will be operated more expensively than in normal times. The difficulty of obtaining coal of a regular quality is sufficiently known to engineers and factory owners. A system of analytical accounting of coal consumption and respective horsepower development under these circumstances is of especial value.

Labor Second Factor of Importance in Power Cost Accounting

Another permanent expenditure affecting the cost of power production is that of labor. The staff of the power house varies, of course, a good deal according to the type of the installation and its horsepower development. Gas, gasoline machines or electrical motors, of course, require a smaller staff than big steam plants where coal passers and firemen add to the number of men in attendance. No attempt need be made to fix the number of men that should be employed normally in a power house, as this is largely a matter of convenience. No doubt, too many hands will make power production unnecessarily costly to the manufacturer. The wage factor differs in this respect from most of the other factors influencing power cost that variations are not as frequent.

After the number of men to be employed in the power house has once been established definitely by experience there will be few changes. Wages, of course, have risen a good deal during the last years. During the last year alone there has been an increase at the rate of at least 20 per cent. This rise, however, has been steady and in its effect on the cost of power production it cannot be compared with the frequent changes in coal values, cost of repairs, maintenance, etc. For the purpose of sound power house accounting it is nevertheless of importance to know to what extent the wage and salary factor has affected production. Not all labor performed in a power house is essentially connected with power production. Much work has to be done which, for instance, should be accounted really to the item of maintenance.

Some difficulty seems to exist under which heading it should be entered for statistical purposes. While it must be regarded as a principle of statistical accounting that every cost factor has to be entered exactly there where it exerts its influence, there must, however, be allowed some leniency. If the work is performed by a man who is a permanent member of the staff of the power house and carried as such on its wage roll, the wages paid to him belong properly under the heading of salaries and wages. So a boiler cleaner who is in the employ of the power house exclusively should be carried under this heading. Should his duties, however, be temporary only, his wages must be charged under that heading of the account where his special duties were performed. It seems that in all cases the work which is performed by outside labor has to be considered in connection with the improvement done. It is less labor than merchandise bought by the power house from outside sources.

As already indicated, wage changes have taken place in all classes of power house employes. Also in many instances a reduction in the efficiency of men has been noticeable. Both are factors which have led to a considerable increase in the cost of power production. Not only have the higher wages added to the increase of the power production of the plant, but the necessity of employing more men owing to the falling off of individual efficiency has actually decreased the production of power per head of each man. If an analysis of the wage factor in its relation to power production may be of little value to the power houses, it seems to be more or less a necessity just now. Such an analysis, therefore, belongs in the realm of this work and should be included.

Material and labor are the two principal cost factors of all national production. In power production the place of the former is taken by fuel. All other costs accrue not from actual production, but rather from the upkeep of the means employed for the purpose of production. The oiling of a machine does not add to its productive value, but it keeps up its standard of efficiency; the machine equipment itself is only the aid to production. All other work done in the power house and all other expenditure incurred after fuel and labor have been provided for concerns that one big item of maintenance. It includes the cost for depreciation of the machine equipment and the cost and labor expended to present such depreciation. On the other hand, neither labor nor fuel will be applied to their full advantage unless the plant in general keeps up its efficiency.

Relation of Production Cost to Original Cost of Power Plant

The power engineer takes over the completed power plant. He is, therefore, not concerned with its initial cost, but takes its existence for granted. The bookkeeping and analytical accounting system of the power plant, therefore, reasonably should not be loaded, as far as he is concerned, with the original cost of the building and equipment, which belongs rather in the books of the mother concern. All the engineer can do is to produce power as cheaply as possible with the means which are put into his hands. If these means are faulty or have been too costly originally, he should not carry the responsibility. On the other hand, the initial cost of the power plant plays an important part in establishing the cost of each horsepower to the manufacturer. As this is a cost factor which can be changed only with great difficulty after the plant is put into operation, it is necessary to inquire into its bearing on

have the satisfaction that the efficiency of the plant was kept on the highest level, with the result that the aver- power cost before the power house is constructed and the equipment put in.

From the same reasons it appears that interest charges on the capital invested originally in the power plant do not belong properly in a statement as to the cost of power production of the power plant, but rather in the general books of the enterprise.

The principal reason why this should be so seems to be the different purpose of the cost analysis made by the power engineer from that of the central counting house, which was explained. Capital charges have only an indirect influence on the production; their addition to the statistics of production would rather tend to cloud the result. Also a rise or fall in the interest charges on the power house investment is out of the control of the engineer. Common sense, therefore, seems to exclude it from the power house accounting proper.

Depreciation of Equipment

The situation is somewhat different with reference to depreciation. While all authorities seem to be inclined to charge it to the production account, there is some difference in the opinion as to handling each of the buildings and the machine equipment. The buildings are not absolutely essential to power production. The power plant may be housed in a part of the principal factory building or in a special building, as is the case in most big enterprises where steam generation is used. The cost of this building is already charged to the general account of the enterprise, and it is therefore not very practical to charge the depreciation of the building to the power plant, as in theory at least it is not the owner of the building.

On the other hand, the firm might think it advisable to make the power station a special charge in its books for rent. Such a charge should not appear in the accounting of the power plant. The depreciation of the machine equipment of the power plant, however, is a factor which belongs in the field of power production. It is estimated that 6 per cent is a safe rate of depreciation of machinery in this country. According to the size and costliness of the equipment the amount of depreciation varies, of course, a good deal. It may be hard on the power house engineer to find himself with a machine equipment unduly costly and, therefore, costing him a large amount of depreciation. He has, however, the satisfaction that by writing off every year a considerable part of the original investment he reduces automatically his own cost of production. If by a careful handling of the equipment he finds himself with most of the amount written off and a sound equipment on hand, he has a decided advantage. The whole charge belongs under the general heading of maintenance.

Repairs

Keeping the plant always in good repair and at the highest of its productive efficiency is a work which can never rest; it is part of the operation of the power house. So is the expense connected with this work and the purchase of essential supplies. Labor and money expended in repair and maintenance, therefore, very properly is charged amongst the permanent charges of the plant. Maintenance and repair are essential for the smooth operation of the plant. If they are neglected the result must be a decline in power production. This may appear in many a form, less power may be produced or more labor or fuel may be required to keep up the standard of the product. A boiler not kept in good repair is not only a dangerous thing to have around, but it will also consume more coal than one in the pink of perfection. Negligence in making repairs depreciates the good effect of the other factors influencing production.

On the other hand, an increase in the cost of repairs caused by worked out equipment needing much repair work and attendance will tend to increase the cost of operation. The question then arises whether it will be cheaper to continue making repairs or whether a renewal of the affected unit of the equipment is more advisable. To make this decision it is necessary that the extent of the repairs be known. In estimating the effect of repairs on the cost of production it is necessary that no expenses should be charged to repair work which are not connected directly with it. If the repairs are done by the staff of the power house the item of labor is taken care of already in the wages account. Rarely a special man will be employed for the only purpose of doing repairs; even in this case it seems better to charge his wages under the general wages account. Supplies bought for repair work, however, are incidental to the maintenance of the plant and in an analytical account should be noted under that item.

Tools and General Supplies

A question is whether tools bought for the plant should be charged to repair and maintenance. The principal purpose of making a statistical account must remain to get a clear statement of the influence of each item on the cost of production. Tools are rarely bought for the sole purpose of repair or maintenance work only. It is advisable to have a special column for tools and incidental supplies for all such purposes that cannot be charged properly under one or the other heading.

An analysis should be made as to the cost of repairs for each horsepower produced. This is made for the purpose of showing whether the plant requires an uncommonly high outlay for repairs to uphold its productive efficiency.

Renewals

Renewals are a charge on the cost of production. Renewals of equipment are generally made only when the unfitness of the old equipment has been proved to the satisfaction of the power house engineer. Such unfitness will show principally in the reduction of the efficiency of the plant caused by the unserviceable state of the equipment. When the standard of efficiency declines the number of horsepower produced by the plant will decline correspondingly, with the result that each horsepower that is produced may cost the plant more in labor and fuel. For this reason the cost of renewals cannot be regarded independently from the general expenditure of the production. The yearly statement may show that more money was spent on renewals of equipment than during the preceding, but the engineer will

age cost of production has remained the same as before.

It is an interesting question whether renewals are costs of maintenance or equipment. There is a consensus of expert opinion that everybody may please himself in this respect. It seems, however, the more practical to treat renewals as part of the equipment. Renewals as an expense factor more or less counteract the influence of the depreciation factor on the machinery. Expenses for renewals also vary a good deal. Less renewals will be necessary during one year than during another. The amount, as a rule, will be heavy and will apply not to the whole plant but to individual units. General maintenance of the plant, on the other hand, is affecting the power house as a whole. It is continuously incurring labor and expense.

Additional Equipment

Additional equipment as a cost factor differs in its economic valuation from the cost factor of renewals, insofar as an expenditure for renewals is already completely justified when nothing else has resulted from it but the keeping of the efficiency on the pre-existing level, while additional equipment in most cases means an extension of the efficiency of the plant. It adds to its productive capacity, and the result of the added equipment should be either an increase in the total number of horsepower that are produced or a considerable reduction in the cost of running the plant by producing the same number of horsepower. The new equipment must be an asset and not a charge. Its cost consequently must be charged to the power plant if only so as to impress all the staff of the plant with the necessity of not making unnecessary proposals for an extension of the equipment if no real benefits can be obtained from it for the factory. As a matter of power house economy, new equipment should not be added unless this equipment as to cost and efficiency will improve the position of the plant as a power producer. A method of accounting which takes cognizance of this factor of new equipment will soon show the engineers the results they can obtain by the employment of new machinery, and it will make easier the checking of the results of experiments. Wherever new equipment is installed its effect on the producing capacity of the plants should be recorded carefully, not only as to the price of each horsepower obtained, but also as to the effect on horsepower production in general.

To Recapitulate

The principal factors influencing power production are: 1, quantity of fuel; 2, price paid for fuel; 3, wages and salaries; 4, maintenance of equipment, including depreciation; 5, repairs; 6, renewals; 7, additional equipment; 8, general supplies and tools.

A cost accounting system containing a statement as to the current expenses of the power house in reference to each of these items will be all that is required to show the influence of each of these factors on the general cost of production of the plant.

The great advantage of all analytical systems of accounting for the power engineer is that it will place the blame for any decline in the efficiency of the plant at the right door. Power losses and power waste may occur in many directions. They may be the result of overapplication of power, of faulty transmission or wrong management. If a careful accounting is kept as to each of the factors influencing power production and is bearing on the total situation of the plant, it will be easy to locate the trouble. If it is suspected that the plant is not producing so well and economically as can reasonably be expected, it will not be necessary to hunt over the whole equipment and make lengthy experiments. The search is outlined clearly by the analytical process. This is no general safety valve for incompetency, nor can it be used in the hand of the sloppy, but if properly conducted it will be of considerable help. Its special value lies in the fact that it will show automatically the bearing of each factor responsible for the economical operation of the plant on the cost of production.

Most important to know, however, to this end, is not how much has been expended actually for each item on the cost sheet, but how each expenditure has influenced the general efficiency of the equipment. An analysis, therefore, has to be made showing besides each expenditure for wages, renewals, additional equipment, and depreciation, etc., also the results obtained by it measured by the productive capacity of the total equipment. The following statistical columns are recommended for the purpose.

Price per ton of coal.
Power produced by ton consumed.
Price of coal per horsepower unit.
Wages and salaries per horsepower.
Depreciation per horsepower.
Repair cost per horsepower.
Renewals per horsepower.
Total valuation of equipment per horsepower.
Total cost of operation per horsepower.

There is, of course, a marked difference between the power engineer producing his own power in an independent power house, whether he used it directly or converts it into electrical power, and the engineer who has his power supplied ready from a central station. The problems of the first are those of production and consumption; the second has to deal with distribution only. His position, therefore, is immensely simplified. For him there exists only the problem of cheapest transmission of power. He knows the cost of every horsepower unit of central station power employed. The economics of the private electrical power plant buying electrical energy in bulk from a central station has of late become a good deal complicated by the increasing practice of buying large quantities of power. In this case the production of the primary power is eliminated, but the problems of handling the secondary power remain. There is the same factor of labor, of renewals, new equipment and maintenance found already in connection with the steam power plant; the economic principle will remain the same.

A Recommendation

In any system of analytical accounting the use of descriptive charts must be highly recommended. Charts and curves have the great advantage that they impress the mind directly.

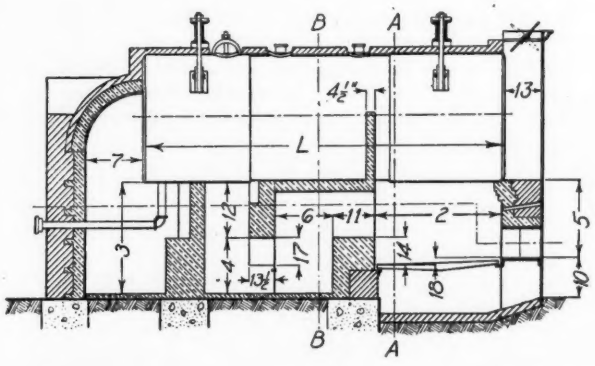
Fuel Economy in Hand-Fired Power Plants---IV*

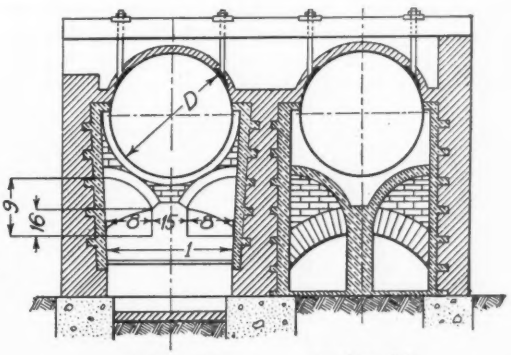
SETTINGS, STACKS AND BREECHINGS

IN ORDER to use soft coal economically, it is desirable to obtain as complete combustion as possible. To obtain proper combustion, sufficient air must be introduced into the furnace to supply the necessary oxygen. The air thus introduced must mix thoroughly with the gases given off by the burning coal, and the mixture thus obtained must be kept at a high temperature until the process of combustion is completed. The old standard setting for return tubular boilers is frequently used, but it does not satisfy the conditions stated, and for this reason should not be used when smokeless combustion is required.

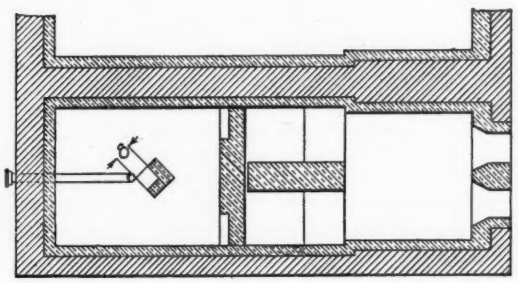
bridge wall or somewhat below it. So as to prevent the gases from passing over the arches, bulkheads extending up to the boiler are constructed above them.

The gases in passing from the grate over the bridge wall are divided into two separate streams by the central pier supporting the double-arch. In going through the retorts formed by the double-arch and the side walls of the setting the gases are thoroughly mixed, and at the same time are subjected to high temperatures. Having passed through the retorts the gases are compelled to change their direction of travel so as to pass under the deflection arch back of the bridge wall, thus pro-





Section AA Section BB



Boiler Dia.	Boiler Length	Dimensions of Double-arch Bridge-wall Setting for Horizontal Return Tubular Boilers. Dimensions in Inches 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
42	12	42	42	42½	27½	28	21	22	16½	15	19	18	15	16	16½	9	9	8	3½
	14		48	44	27		24			17			17		15		11		4
48	12	48	42	45½	30	30	20	24	19½	15½	20	18	15½	18	16½	9	7½	8	3½
	14		48	45½	28		24			17½			17½		16½		9½		4
	16		54	49½	30		26			19½			19½		15		11½		4½
54	14	54	48	49½	30	32	24	24	20½	18	22	18	19½	18	16½	13½	11½	9	4
	16		54	51½	30		24			20			21½		15½		13½		4½
60	16	60	60	55½	33½	34	26	26	23½	22½	22	22½	22	18	17	13½	13	10	5
	18		66	60½	36½		26			24½			24		15½		15		5½
66	16	66	60	54½	34	34	28	28	26½	22½	24	22½	20½	18	18½	13½	11½	11	5
	18		66	59	36½		28			24½			22½		17		13½		5½
72	16	72	66	59½	37	36	30	30	29½	24½	24	22½	22½	20	18½	13½	11½	12	5½
	18		72	64½	40		30			26½			24½		17½		13½		6
78	18	78	72	65	40	38	32	32	30	27½	26	26	25	21	19	18	15½	12	6
	20		78	70	43		32			29½			27		17½		17½		6½
84	18	84	72	64	40	38	36	32	33	27½	26	26	24	21	20	18	14	12	6
	20		78	69	43		36			29½			26		18½		16		6½

FIG. 1. DOUBLE ARCH BRIDGE WALL SETTING FOR SMOKELESS COMBUSTION

A type of horizontal return tubular boiler setting which has given good results with soft coals is shown in Fig. 1. It was originated and perfected by the engineers associated with the Department of Smoke Inspection of the city of Chicago and is generally recommended for boilers operating at a steam pressure of 60 lb. or more. A double-arch rests on the bridge wall and on a suitable pier built up between the bridge wall and a single span deflection arch, the latter being located from 2 to 3 ft. back of the bridge wall. The highest point of this deflection arch is at the elevation of the top of the

moting further mixing and thereby insuring proper combustion. The setting is also provided with the usual panel door for the admission of air over the fire. The steam jets shown extending through the furnace front are generally considered standard equipment, and it is recommended that they be freely used after each firing.

The arches used in connection with the setting shown in Fig. 1 produce a side pressure on the walls, and in order to prevent bulging and cracking of the walls additional buck-stays and tie rods should be installed. The floor of the combustion chamber is subjected to high temperatures, and for this reason should be paved with second-grade fire brick laid on edge.

According to Osborne Monnett the following gen-

* Abstract of Circular No. 7, entitled, Fuel Economy in the Operation of Hand-Fired Power Plants, published by the University of Illinois Engineering Experiment Station.

eral proportions should be satisfied in order to obtain satisfactory service with this type of setting.

(1) The free area through the double-arch above the bridge wall should be made equivalent to at least 25 per cent of the grate area.

(2) The area from the back of the bridge wall to the deflection arch should be at least 45 per cent of the grate area.

(3) The area under the deflection arch should be at least 50 per cent of the grate area.

For convenience of reference the dimensions indicated in Fig. 1 for various sizes of boilers are given in the table presented with the illustration. These dimensions were obtained from a report submitted by the Standards Committee at the eleventh annual convention of the Smoke Prevention Association.

There are several patented settings in which the gases are maintained at a high temperature and are thoroughly mixed by the use of piers and wing walls in place of the arches shown in the setting of Fig. 1. Experience seems to indicate that the temperature in

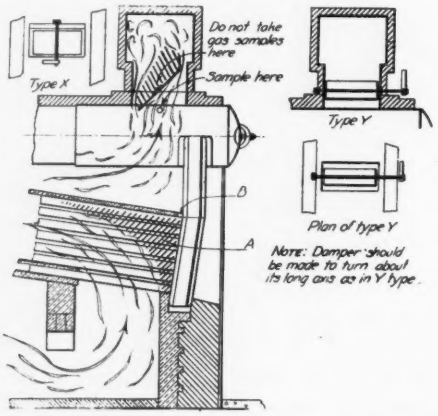

Do not take gas samples here
Sample here
Type X
Type Y
B
A
Plan of type Y
Note: Damper should be made to turn about its long axis as in Y type

FIG. 2. SHOWING EFFECTS OF BAFFLING AND DAMPERS IN CAUSING POCKETS AND EDDIES IN FLUE GAS STREAM

the combustion chamber of such settings is sufficiently high to promote proper combustion, and furthermore it is claimed that they burn coal with good economy and are cheaper to construct that the double-arch setting.

Settings for Water-Tube Boilers

A large number of hand-fired water-tube boilers of the horizontal type designed for the use of soft coal are installed with what is generally called the standard vertical baffling. This form of baffling compels the gases to pass across the tubes, thus producing a rather short flame travel in the first pass and rendering complete combustion impossible. In order to improve combustion in hand-fired water-tube boilers of the horizontal type when burning soft coal, it has been demonstrated by the Chicago Department of Smoke Inspection that the setting should be so arranged as to fulfill the following specifications:

(1) Some provision must be made so that the bottom row of tubes will absorb some heat directly from the fire. This is accomplished by the use of T-tiles, thus exposing the bottom row of tubes to the fire for a short distance from the front header.

(2) Over the bridge wall and for some distance back of it a high temperature zone, through which the gases and air pass, must be provided. This zone is obtained by using box-tiles around the bottom tubes. The box-tiles extend from the end of the T-tiles to a point several feet in front of the back header. The area provided between the bridge wall and the box-tile should be made equivalent to 25 per cent of the grate area.

(3) In order that the gases and air will thoroughly mix, a deflecting arch is provided a short distance back of the bridge wall. The distance between the arch and the bridge wall should be such that the area obtained between them is equivalent to 40 per cent of the grate area. The height of the arch must be sufficient so as to provide an area underneath it equivalent to 50 per cent of the grate area.

(4) As in the case of the horizontal return tubular boiler settings, excess air is provided through the panel doors in addition to a siphon steam jet located above the fire doors.

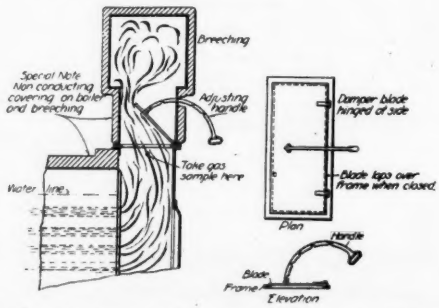


FIG. 3. AN IMPROVED FORM OF HINGED DAMPER

When water tube boilers are very wide, it may be necessary to construct the deflection arch mentioned in (3) in two or three spans, supported on suitable piers in order to relieve the strain on the side walls. In case the area over the bridge wall is in excess of 25 per cent of the grate area, the desired area may be obtained by introducing piers upon the bridge wall opposite the spans in the deflection arch. Due to these piers the gases and air will be more thoroughly mixed, thus promoting combustion.

In water tube boilers equipped with horizontal baffles it generally happens that there are parts of certain tubes which are not acted upon effectively by the gases. This is due to the fact that the gases become trapped in the corners as shown at A in Fig. 2 and become inert. Such a condition can be improved with a gain in the efficiency of the boiler, by providing openings approximately 1 in. wide in alternate rows of tile B, Fig. 2.

One of the most serious defects found in brick settings is air leakage. The fire brick used on the interior of the setting must be selected with great care as the life of the setting very largely depends upon the quality of these bricks as well as upon the workmanship in

laying them. Generally the arches used in settings cause more trouble than any other part of the setting. In some cases arches fail because of the use of a grade of brick not suited to the purpose, but more frequently failures are due to poor workmanship in laying the bricks. Air leakage through the setting can be reduced by pointing up the brick work in the proper manner and by covering the entire setting with an insulating material, as for example a high grade of asbestos or magnesia covering. The exposed parts of the shell of horizontal return tubular boilers and of the steam drums of water tube boilers should be covered with an 85 per cent magnesia covering 2 or 3 in. thick. The outer surfaces of all insulating materials should

TABLE SHOWING STACK SIZES BASED ON KENT'S FORMULA

Diameter Inches	Area Square Feet	Height of stack in feet										Side of Equivalent Square Stack, In.	Diameter Inches
		50	60	70	80	90	100	110	125	150	175		
		Pounds of Coal Burned per Hour											
33	5.94	530	575	625	665	705	745	....	....	....	....	30	33
36	7.07	645	705	760	815	865	910	....	....	....	....	32	36
39	8.30	775	845	915	980	1040	1095	1145	1225	....	....	35	39
42	9.62	915	1000	1080	1155	1225	1290	1355	1445	1580	....	38	42
48	12.57	1230	1345	1450	1555	1650	1740	1825	1945	2130	2300	43	48
54	15.90	1590	1740	1880	2010	2135	2245	2360	2515	2755	2975	48	54
60	19 64	2000	2185	2365	2525	2680	2825	2965	3160	3460	3740	54	60
66	23.76	2450	2685	2900	3100	3290	3470	3640	3800	4245	4590	59	66
72	28.27	2955	3230	3490	3735	3960	4175	4380	4670	5115	5525	64	72
78	33 18	3500	3830	4140	4425	4695	4950	5190	5535	6060	6550	70	78
84	38.48	4090	4480	4840	5175	5490	5785	6070	6470	7090	7655	75	84
		Height of Stack in Feet											
		100	110	125	150	175	200	225	250				
		Pounds of Coal Burned per Hour											
90	44.18	6690	7015	7480	8195	8850	9465	10040	10580			80	90
96	50.27	7660	8080	8565	9380	10135	10835	11490	12115			86	96
102	56.75	8695	9120	9720	10650	11500	12295	13045	13750			91	102
108	63.62	9795	10270	10950	11960	12960	13850	14695	15490			98	108
114	70.88	10960	11495	12255	13425	14500	15500	16440	17330			101	114
120	78.54	12190	12785	13630	14930	16130	17240	18285	19275			107	120
126	86.59	13485	14145	15080	16515	17840	19070	20230	21325			112	126
132	95.03	14850	15570	16605	18185	19645	21000	22275	23480			117	132
144	113.10	17770	18630	19865	21760	23505	25130	26655	28090			128	144
156	132.73	20950	21965	23420	25655	27710	29625	31425	33120			138	156
168	153.94	24390	25575	27270	29870	32270	34495	36590	38565			150	168

be finished off with a thin coating of hard cement or covered with canvas and painted. If the walls of the setting are constructed with air spaces these spaces should be filled with sand or ashes. The baffles on the interior of the setting should be kept tight so that the gases cannot be by-passed through the heating surfaces.

Stacks and Breechings

The purpose of a stack is, of course, to supply air to the fuel which is burning on the grates of the boiler furnace and then to remove the flue gases which are formed after they have passed over the boiler surfaces and given up most of their heat to the water and steam in the boiler. The stack may waste coal if the fireman allows it to supply too much or too little air, or if he allows the flue gases to leave the boiler at too high a temperature. Most stacks supply too much air so that a large amount of heat is carried away in the unnecessarily large volume of flue gases formed when this air passes through the fuel bed, where it not only serves to burn the coal but also takes up heat.

In order to control the amount of air and flue gas passing to a stack, a damper should be installed at the point where the flue gas leaves each boiler. This damper should fit tight and true and should move easily. An approved form of damper, which is tight fitting, is shown in Fig. 3. It should have a free opening about 25 per cent greater than the area through the tubes. Long narrow dampers are to be avoided wherever possible. For water tube boilers the damper opening should be about 0.25 of the grate area. The damper must be opened only enough to permit the stack to supply the right amount of air to burn completely the fuel fired. When the demand for steam increases, more coal must be burned and the damper must be opened wider in order to supply more air. The air supply should not

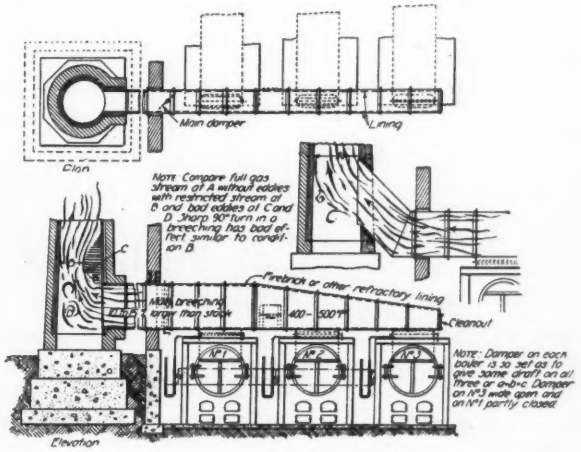

Main damper
Lining
Clean
Note Compare full gas stream at A without eddies with restricted stream at B and bad eddies at C and D Sharp 90° turn in a breeching has bad effect similar to condition B
Firebrick or other refractory lining
Main breeching larger than stack
400- 500°F
Cleanout
Note: Damper on each boiler is so set as to give same draft on all three at a-b-c Damper on N°3 wide open and on N°1 partly closed
Elevation

FIG. 4. STACK AND BREECHING CONNECTIONS FOR A BATTERY OF THREE BOILERS

be controlled by opening and closing the ashpit doors, which should stand wide open practically all the time. If the stack is not controlled by the damper, it will always exert its full power on the setting, which means that the tendency for air to leak in at any cracks and joints will be as great at half load as at full load, and even with the ashpit doors closed this leakage would be unchanged if the stack damper remained open.

In order that the approximate capacity of a stack may be checked against the load it should carry, the table herewith has been arranged in convenient form for ready reference. Thus, if a certain boiler plant is burning 2800 lb. of coal an hour at its maximum capacity and the stack is 100 ft. high, the diameter should be 60 in.

This table is a modification of William Kent's stack table and is reliable for the ordinary rates of combustion with bituminous coals. The values in the table give the pounds of coal burned per hour. With coal of fair grade it is necessary to burn about 5 lb. per

boiler horsepower, but with low grade bituminous coal it is necessary to burn from 6 to 8 lb. per boiler horsepower.

Air Leaks Affect Draft and Waste Coal

If cold air leaks into the setting at any point, it will result in two forms of fuel waste. First, it will cool the gases in the setting and in the chimney and will make the draft less. This may make it difficult to burn the fuel properly. Secondly, the air which has leaked in must be warmed up, thus taking heat away from the boiler and wasting it through the chimney, and finally this air will so increase the volume of flue gas that it may be difficult for the chimney to handle the increased volume of flue gas even with the damper wide open.

Many breechings serving more than one boiler are condemned as being too small because so much unnecessary air is leaking into the various settings that the breeching cannot handle both the leakage and the necessary flue gas. By systematically stopping all the leaks such a breeching will often easily handle the flue gases resulting from the minimum air supply actually required for burning the fuel. Breechings should be at least from 10 to 15 per cent greater in area than the stack to which they connect.

The individual boiler dampers in the throat or uptake connections opening into a breeching should fit accurately and close tightly, otherwise it will be impossible to prevent cold air from entering the main breeching through the damper of a "dead" boiler. This will often seriously affect the operation of all the other boilers by "checking" the draft of the stack which serves the boilers connected to this breeching.

Breechings should be as short and straight as possible, and should have no sharp angles around which the flue gases may swirl and eddy in their passage to the stack. The bad effect of sharp angles is shown in the stack connection marked "B" in Fig. 4. The method of correcting this difficulty is shown at "A" in the same figure. Breechings should be covered with a good heat insulating material or lined with a refractory brick or vitrified material.

All boiler dampers should be "calibrated," that is, should have the operating lever or chain so marked and set that the draft for boiler No. 1, nearest the stack (Fig. 4), will be no greater than for boiler No. 3, farthest from the stack, when both boilers are clean and have the same thickness of fuel bed. To accomplish this result it may be found that the damper on the nearest boiler must be nearly closed most of the time. If all dampers are set at the same angle without regard to their location with reference to the stack, too much air will go through the nearest boiler or the farthest boiler will get too little air and suffer a loss in capacity.

Construction of Alinement Charts

Working Formulas of Three Variables Into Simple Alinement Charts. By Ralph E. Turner

ENGINEERS frequently find themselves confronted with a series of problems involving the same equation with varying known values such as, perhaps, the results of tests. These can in many instances be worked out on a slide rule to best advantage, but many times a constant appears which necessitates an extra setting or an unusual root or power is involved which requires extreme care in solution with the common slide rule. For use on such occasions, calculating charts designed especially for the equation used are frequently the most convenient means for solving problems, and it is the purpose of the author to give a few directions for laying out some of the simpler charts which can be made quickly as the need presents itself.

The most easily constructed calculating chart consists of three parallel lines carefully graduated and spaced at the proper distance apart; it is known as the alinement chart and is useful where quick estimates are desired. The accuracy varies with the range of the chart, the best results being obtained when the straight edge used in working with the chart is nearly perpendicular to the graduated scales, the limiting angle should not be less than about 45 deg. from the scale lines.

These charts may be constructed to perform addition, subtraction, multiplication, division, raising to powers and extraction of roots.

Adding and Subtracting

To construct the chart for addition and subtraction, quadrille ruled paper is found convenient. First decide the range of the variables and the allowable dimensions of the chart, recognizing that the farther the scales representing the known variables are apart and the longer the unit divisions, the greater will be the accuracy of the chart.

Referring to Fig. 1, let A and B represent the scales of known variables whose sum is to be found. These scales are evenly divided, and in this case equal. Under such circumstances the scale representing the sum is located exactly midway between the scales A and B and its graduations are even, but half as far apart as those on A or B. It remains then only to draw the line C midway between A and B and scale it off in divisions equal to half those of A, all scales having their zero point in the same perpendicular to the graduated lines. In tracing this chart, the net work of the quadrille paper is left off, showing only the three scaled lines.

To use the chart, place a straightedge from one number, say, 14, in Scale A, to the other number to be added, say, 6, in scale B, and read the answer in scale C, which is 20.

Subtraction is the reverse; that is, starting with the minuend in scale C, place the straightedge across to the subtrahend in either scale A or B and read the difference in the other scale.

When it is found desirable that scales A and B should not have equal divisions, the locating of scale C

and graduating it are not so easily done. Take, for example, Fig. 2, in which the unit scale divisions in scale A have a length equal to 2/3 that of the unit divisions in scale B, giving to scale A a range of 1½ times that of scale B. There is a simple relation which exists between the location of scale C with relation to scales A and B and their graduations, which may be stated thus:

Unit divisions in scale A are equal to 2/3 the length of those in scale B. Divide the distance between scale A and scale B into 5 (indicated by the numerator plus the denominator of the above ratio) equal parts, scale off 2 (represented by the numerator) of these parts from scale A towards scale B and erect through this point line C, which is to be graduated.

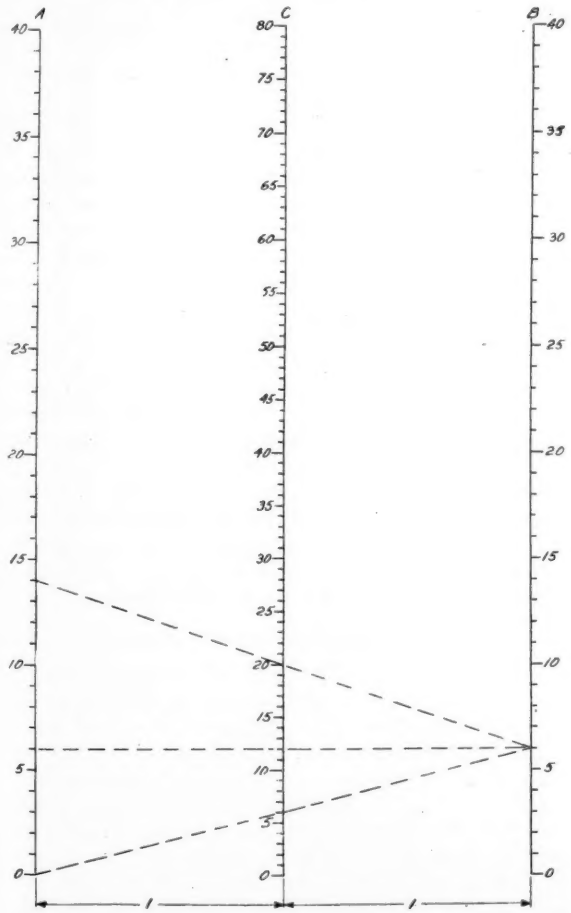


FIG. 1. ALINEMENT CHART FOR ADDITION AND SUBTRACTION WHERE QUANTITIES TO BE ADDED HAVE ABOUT THE SAME RANGE

Unit scale divisions in scale C are 3/5 as long as those in scale A; the numerator in this ratio is the denominator in the ratio between scale A and scale B, and the denominator is the sum of the numerator and denominator in the first ratio.

Here are a few examples for different ratios:

Length of Unit Div. Scale A ÷ that of Scale B.	Ratio of Spacing Between Scales. Scale A to Scale C.	Scale C to Scale B.	Length of Unit Division Scale C ÷ that of Scale A.
1/1	1	1	1/2
3/4	3	4	4/7
2/3	2	3	3/5
3/5	3	5	5/8
1/2	1	2	2/3
3/7	3	7	7/10
1/3	1	3	3/4
1/6	1	6	6/7

MULTIPLICATION AND DIVISION

THE ALINEMENT chart for multiplication and division is used much more than the addition chart, but its

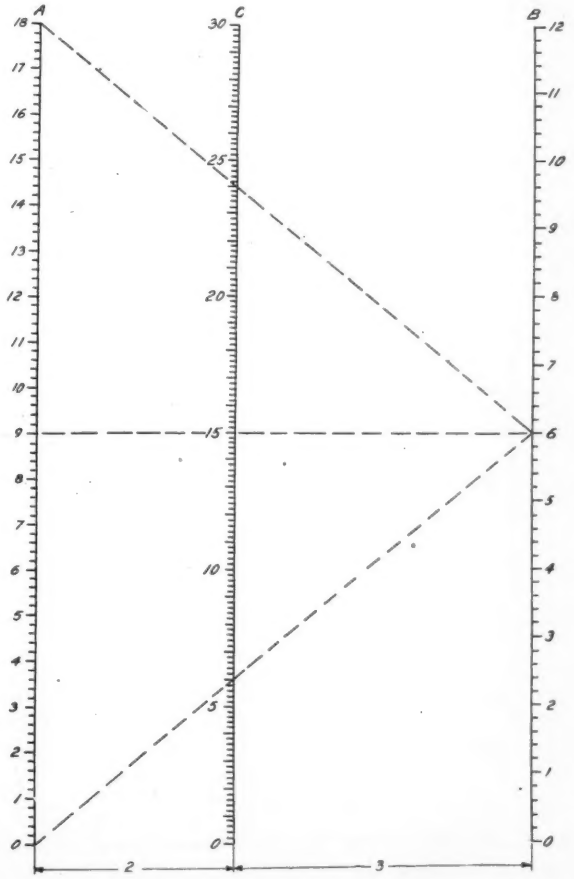


FIG. 2. CHART FOR ADDITION AND SUBTRACTION WHERE RANGE OF THE NUMBERS TO BE ADDED IS DIFFERENT

construction is upon precisely the same principles except that the lines are graduated in proportion to the logarithms of the numbers. Algebra teaches that to multiply numbers we add their logarithms; the sum will be the logarithm of their product, so this is what we do when we multiply by means of the alinement chart.

To illustrate this Fig. 3 is drawn with the lines divided to an even scale on one side, which graduations represent the logarithms of numbers. On the other side of the lines are the corresponding numbers. Each line of this chart, it will be recognized, takes the form of a simple chart with the numbers on one side and their corresponding logarithms on the other. This may be scaled off by referring to a table of logarithms, or from a slide rule scale.

The spacing of these lines is done exactly as is outlined for addition and subtraction, remembering, of course, that we work from the scales of equal divisions.

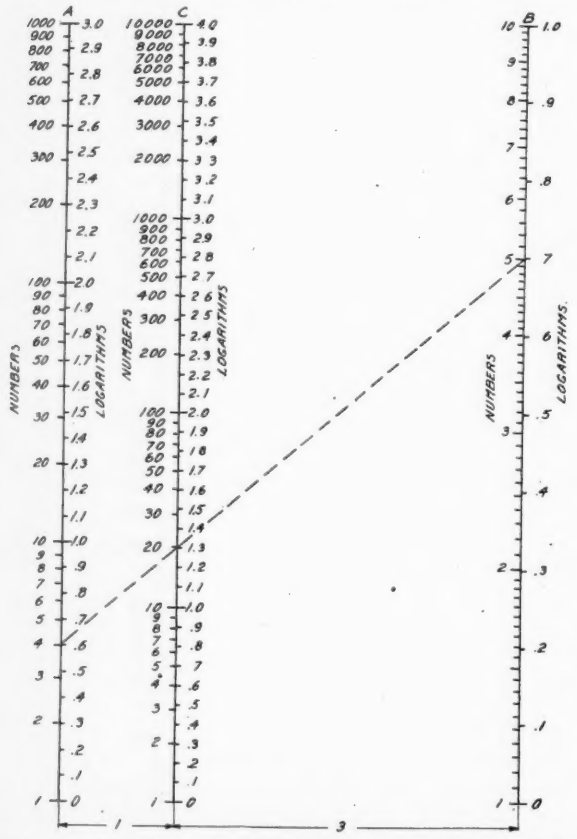


FIG. 3. CHART FOR MULTIPLICATION AND DIVISION WITH EXTRA DIVISIONS TO ILLUSTRATE HOW MULTIPLICATION IS PERFORMED BY ADDITION OF LOGARITHMS

After the chart is laid out, the scales of equal divisions are omitted from the finished chart, as they are likely to cause confusion. If, however, the equal divisions are left on the chart, it can be used not only for multiplication and division but also for addition and subtraction.

To illustrate with an example how to use this chart, suppose we wish to multiply 4 by 5. In column A on the numbers side we find 4, and from this point to 5 on the numbers side in column B we place a straightedge; where it crosses column C we find 20 on the numbers side, which is the product.

On the logarithms side of the chart we note that we have simply added; thus the log of 4 is 0.6021; of 5, 0.6990; the sum is 1.3011, which is the log of 20.

Division, of course, is the reverse of multiplication, corresponding to the subtraction of logarithms.

To construct these charts, first determine the limiting values of the known variables, then decide upon the most desirable size of chart, keeping columns A and B separated as far as practicable in order to increase accuracy. It will usually be found most convenient to make lines A and B nearly the same length.

It will be noted that with the logarithmic scale the characteristics of the numbers make even divisions on the scale; this makes a convenient basis upon which to work. Assume, for example, that one known variable ranges from 1 to 1000, and that the number by which it is to be multiplied may vary from 1 to 10, as has been worked out in Fig. 3. We note that the characteristic of the logarithm of 1000 is 3, so we divide scale A into 3 equal divisions, as indicated, then graduate each division into the logarithmic scale.

The logarithmic characteristic of 10 is 1, so scale B has but one even division, which is equal in length to 3 divisions in scale A. Scale C will have 3+1 or 4 even divisions, according to the logarithmic characteristics of the products. This, again, we note is nothing more than an addition chart and may be constructed in a similar manner as to location of the scales. Having located the four scales, graduate each division pointed off by the characteristics into a logarithmic scale and the chart is complete.

The most convenient means I have found for graduating these scales is first to locate the even divisions of the scales, as has been explained, on tracing cloth, then slip a chart with lines radiating from a point to a true logarithmic scale, as shown in Fig. 4, under the cloth until the radiating lines just fill one characteristic division of the scale to be graduated. It is then an easy matter to graduate the lines by making short lines where the radiating lines cross the scale lines.

Reading the Logarithmic Scale

By those not familiar with the logarithmic scale, difficulty is sometimes experienced in reading it. A word of explanation here may not be out of place. Consider an ordinary inch rule with divisions 1/10 in. apart; there would be no difficulty in locating, say, 2 3/10 or 6 8/10, or using the decimal system, 2.3 or 6.8. Now if your dimension was halfway between 3.7 and 3.8, it would naturally be 3.7½, or 3.75. In this case you have estimated the last or third significant figure of your dimension; this process is called interpolating. Instead of being ½ or 0.5, the distance from the lower scaled division may have been 0.2 or 0.3 or 0.7, 0.8 or 0.9 of the 1/10-in. division; your judgment must tell you that. Thus you read directly inches and tenths of inches and interpolate the hundredths of inches, giving three significant figures.

The same method is used in reading the logarithmic scale; but owing to the variation in distance between the main divisions of the scale, the lower end of the scale has more divisions than the upper; this enables

greater accuracy in reading the lower end of the scale, while too fine divisions would only cause confusion. So in reading the logarithmic scale, read first the main division, corresponding to inches on the foot rule, then note the number of subdivisions in this section of the scale; if 10, each subdivision represents a unit in second place of your reading; if 5 subdivisions each represents 2 units in the second place; if 20, as sometimes in the lower scale, each division represents 5 in the third place, other figures must be interpolated.

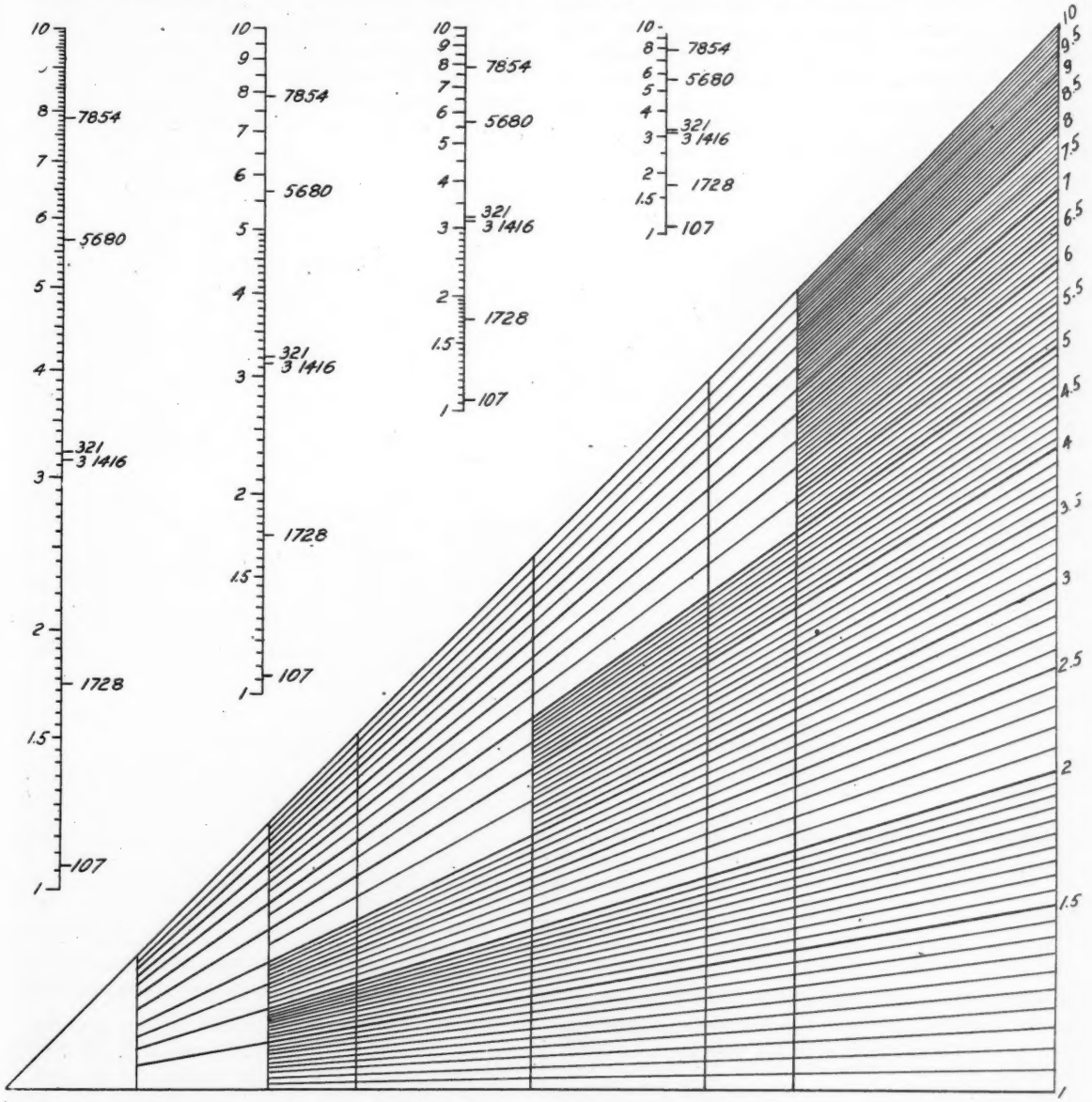


FIG. 4. CONVENIENT CHART FOR GRADUATING LINES INTO THE LOGARITHMIC SCALE, AND GRADUATED SCALES ILLUSTRATING METHODS OF READING

To make this clear, I have located several points on scales with various methods of subdividing in Fig. 4. It will be seen that we can locate definitely only the first three or four figures of a number on the ordinary length scale, so the chart can be accurate only this far, which is usually sufficient for engineering computations.

Alinement Charts for Powers and Roots

In using logarithms to raise numbers to powers, you multiply the logarithm of the number by the power to which it is to be raised, then find the number of which this product is the logarithm; and this is the power required. The extraction of roots is the reverse; that is, by dividing the logarithm of the number by the root to be extracted, and finding the number of which the quotient is the logarithm.

The alinement chart for this purpose is based upon this principle and is laid out as follows:

Referring to Fig. 5, B is the common logarithmic scale and represents the exponents. A is the scale of numbers and is graduated by first laying off a logarithmic scale, the same length between 0.1 and 1 as 1 to 10 scale B; then by referring to a logarithmic table, place the numbers opposite their respective logarithms which are represented by the original scale; this gives scale A, as in Fig. 5, which is known as a log log scale.

Scale C is midway between A and B and represents the powers of the numbers in column A. It is a log log scale and is graduated by first laying off a logarithmic scale from 0.1 to 10, the length in this case being the same as B. Then referring to the table of logarithms, plot the numbers opposite their respective logarithms. Scales A and C have been extended here merely to illustrate the method.

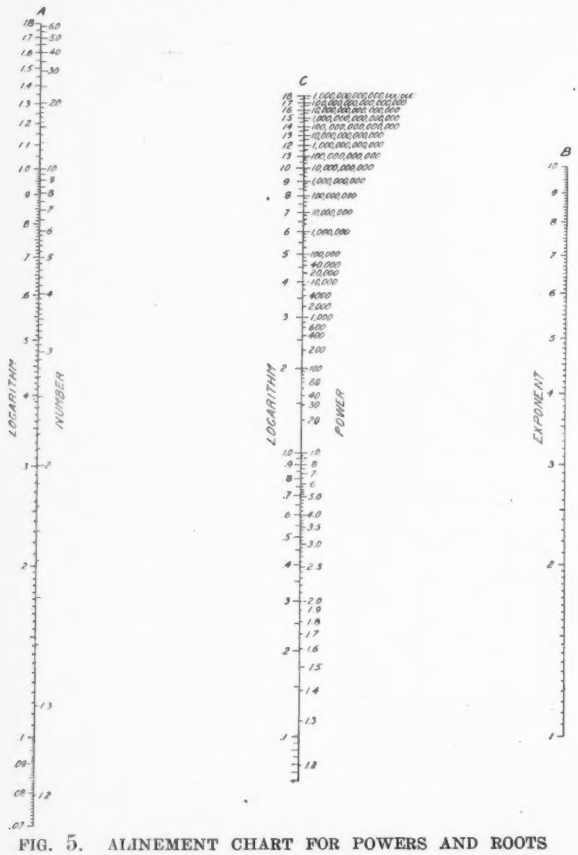


FIG. 5. ALINEMENT CHART FOR POWERS AND ROOTS

The same principle of scale length and spacing rules in this case as has been explained for the multiplication chart, so that if it is desired to limit the range of the exponents it may be done by widening the divisions in scale B and bringing scale C closer to scale A. For fractional exponents the chart would be extended downward from the bottom.

Providing for Constants in Additive Charts

Wherever constants are encountered in an equation they are taken care of by merely shifting one of the scales up or down. For example, the watts input, W, of a transformer is equal to the watts output, w, plus the copper loss, c, plus the iron loss, I. Now the iron loss, I, is a constant for any given transformer and frequency of alternations. The formula may be stated

$$W = w + c + I$$

Supposing I to be a constant equal to 15, this equation may be worked out on a chart similar to Fig. 1 by starting scale B with zero at the present location of 15. Then scale A would represent watts output, w, scale B copper loss, c, and scale C watts input, W. Knowing any two of these, such as watts input and watts output the third variable, watts copper loss, may be read on its proper scale by the use of a straightedge. The chart shown in Fig. 6 is worked out for this particular problem with scales proportioned and spaced to give more accurate readings within the range the variables are likely to take.

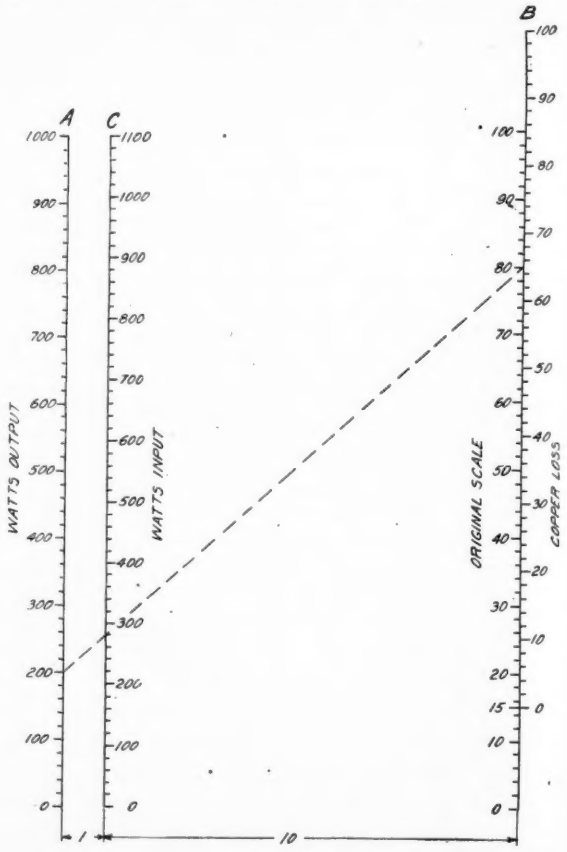


FIG. 6. CHART FOR CALCULATING TRANSFORMER COPPER LOSS WHEN INPUT, OUTPUT AND IRON LOSS ARE KNOWN

In this case, the divisions in scale B are ten times as long as those in scale A; the spaces between scales are as 1 and 10. Unit divisions of scale C are 10/11 as long as those in scale A and may be laid off by dividing the distance between 0 and 1000 scale A into eleven equal parts then subdividing proportionally, or, as was done in this case, by using a straightedge and

placing it at 100 in the original scale B and to the various numbers in scale A, scale C can be plotted as the sums of these numbers. This is an easy and practical method.

Charting Formula with Constant Multiplier and Exponent

To illustrate a more complicated formula, and one which requires considerable mathematical calculation to solve, I have selected Hodgkinson's formula for columns. The solution of this involves nearly all the principles explained above and results in a very simple chart, the solution to the problems being given by one position of the straightedge.

P = crushing weight in pounds.
d = diameter in inches.
L = length in feet.

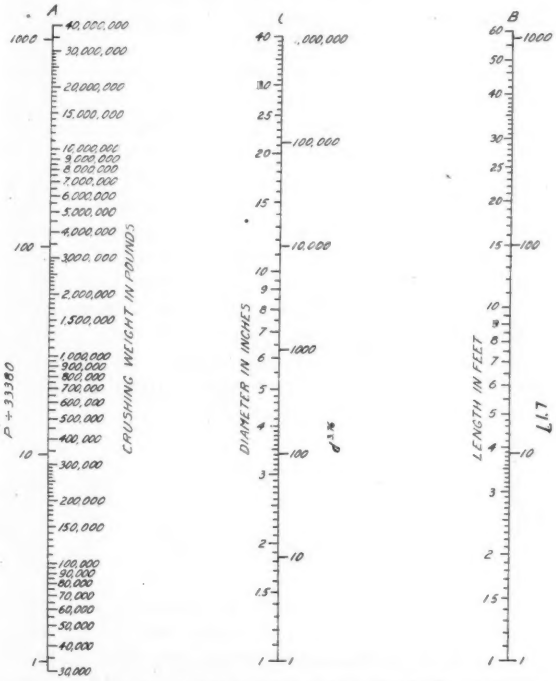


FIG. 7. CHART FOR CALCULATING HODGKINSON'S FORMULA FOR CAST-IRON COLUMNS

Then for a solid cylindrical column of cast iron, with both ends rounded or free to turn, the length of the column exceeding 15 times the diameter:

$$P = 33{,}380 \times d^{3.76} \div L^{1.7}$$

Transposing, we get

$$\frac{P}{33{,}380} = \frac{d^{3.76}}{L^{1.7}}$$

Thus we get a formula with three variables, each of which is affected by a constant; i.e., P has a constant divisor, d and L each have constant exponents. Taking this problem step by step, we first decide on the probable limits of d and L and conclude that d may vary from 1 to 40 in. and L from 1 to 60 ft. By the use of Fig. 5 we find that $d^{3.76}$ varies from 1 to 1,000,000 and that $L^{1.7}$ varies from 1 to 1000.

Next we note that $d^{3.76}$ is the dividend and $L^{1.7}$ the divisor, also that the characteristic part of the logarithm of the highest value of d is 6 and that of L is 3, so we make scale B and scale C the same length, the divisions in C being half those in B; this gives us even spacing of column C between columns B and A and makes our original scale A the same as scale B. Scales A and B we divide into 3 equal parts, labeling the division points 1, 10, 100 and 1000, as indicated. Scale C is divided into 6 equal parts, with the division points labeled 1, 10, 100, 1000, 10,000, 100,000 and 1,000,000. The skeleton chart as it now appears has the three scales labeled $P \div 33{,}380$, $d^{3.76}$ and $L^{1.7}$. The next step is to provide for the constants in such a way that we need read only the variable upon the proper scale; thus when we read in scale B the length in feet the point so located is $L^{1.7}$ on the skeleton chart.

To do this we start with scale B, measure the distance between 1 and 10 on the $L^{1.7}$ scale, multiply this distance by 1.7 and lay it off from 1 up; it reaches 10 on the "length in feet" scale. This is a unit logarithmic division and we scale it off by aid of Fig. 4 and repeat the scale up to 60, which is the probable limit of the variable. We label this scale "length in feet," and the constant exponent is now taken care of.

In the same manner, the scale of "diameter in inches" has a unit logarithmic division (1 to 10) equal in length to 3.76 times that on the opposite side of the line (scale of $d^{3.76}$), as shown on the left of column C.

To care for the constant in scale A it is necessary to multiply the skeleton value by 33,380. This is done by shifting the scale so that 3338 on the new scale occupies the same position as 1 on the skeleton scale, the length of divisions being exactly the same; the new scale is then labeled as indicated.

To avoid confusion the original or skeleton is omitted in tracing and the chart is complete. The accuracy of such a chart is, of course, not absolute, but is sufficiently so for practical purposes.

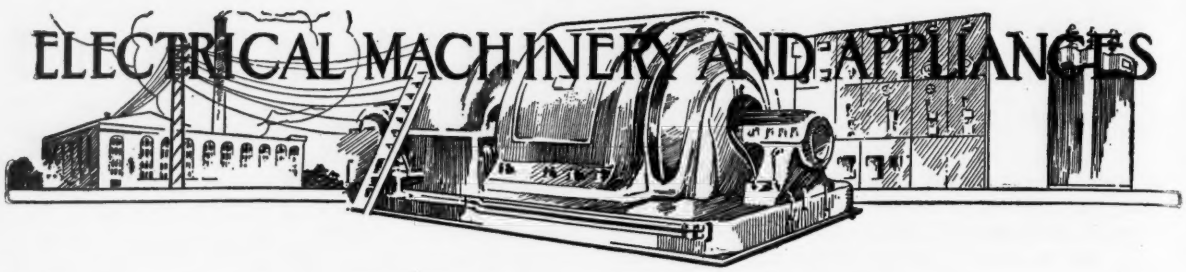
Power Plant Conservation

In a recent letter the United States Fuel Administration says:

"Education of the manager, engineer and fireman in steam and fuel economies is an essential feature of the campaign for the conservation of fuel.

"It is regarded as essential to such education that every manager, engineer and fireman should read regularly a good power plant journal. This practice thoroughly observed would undoubtedly result in the conservation of huge quantities of coal and a corresponding saving of money.

"The shortage of coal will not stop with the cessation of the war, and fuel conservation will continue to be a vital necessity in the industrial future of this country and of the Allies. It has become not only a national problem, but one of international importance. In addition to this consideration it may be stated that scientific conservation of fuel either in peace or in war always means a profit to the plant owner."



The Oxide Film Lightning Arrester

DESCRIPTION OF CONSTRUCTION AND PRINCIPLE OF OPERATION. BY CROSBY FIELD

THE functioning of the oxide film lightning arrester depends upon the fact that certain dry chemical compounds can be changed with extreme rapidity from very good conductors of electricity to almost perfect non-conductors by the application of a slight degree of heat. Lead peroxide is a good example of such a substance. It has a specific resistance of the order of one ohm per inch cube. The resistance varies with the pressure to which it has been compressed. At

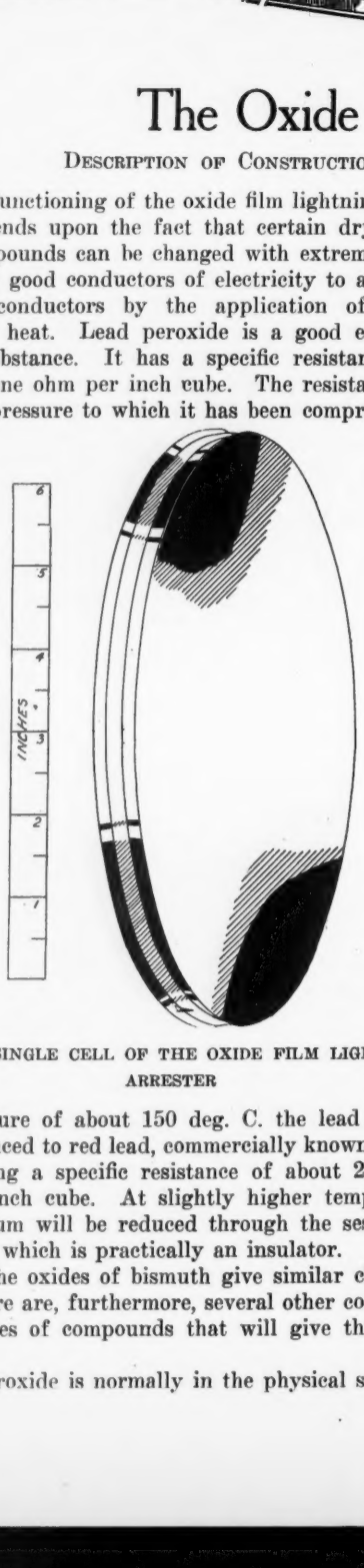


FIG. 1. SINGLE CELL OF THE OXIDE FILM LIGHTNING ARRESTER

a temperature of about 150 deg. C. the lead peroxide will be reduced to red lead, commercially known as minimum, having a specific resistance of about 24,000,000 ohms per inch cube. At slightly higher temperatures this minimum will be reduced through the sesquioxide to litharge, which is practically an insulator.

Again the oxides of bismuth give similar characteristics. There are, furthermore, several other compounds and mixtures of compounds that will give these same results.

Lead peroxide is normally in the physical state of a powder. If this powder be placed between two electrodes and a current passed, the temperature due to the resistance at the contact of the peroxide and the metal will cause heat to be generated locally at the surface. When this heat is sufficient to create a temperature of about 150 deg. C. a film of the lower oxides of lead forms, producing a film of insulation which stops the current. This method of film formation over any large area is rather irregular, and, of course, the oxide is not used in such a fashion in the commercial arrester. Instead of this formation of litharge film any insulating film may be put on the electrodes initially. As insulating film spread on the metal plates there have been used thin layers of the following: glass, water glass, halowax, cloth, balsam, shellac, oil, paints, lead paints, varnishes and lacquers of all available kinds. In all cases the results are similar, varying only with the voltage at which puncture of the film of insulation occurs.

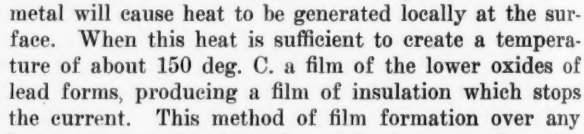


FIG. 2. DISASSEMBLED PARTS OF OXIDE FILM LIGHTNING ARRESTER. FROM LEFT TO RIGHT ARE SHOWN STEEL DISK SPUN ON RING OF PORCELAIN, BROWN PEROXIDE OF LEAD, SECOND STEEL DISK AND ASBESTOS WASHER

The commercial oxide film arrester comprises two sheet metal electrodes, set about 0.5 in. apart, one or both covered with a thin insulating film and the space between the plates filled with some such substance as that described above, as, for example, lead peroxide. Figure 2 shows the disassembled parts of a single cell. At a permissible voltage of 300 v. per cell the insulating film prevents any appreciable current flowing under normal conditions. As soon as the voltage rises slightly above normal the film punctures in one or more microscopic points, the lightning charge meets with practically no resistance and flows to earth, Fig. 3. The dynamic current starts to follow, but because of the fact that the insulation was punctured in such fine points, the current density near these points is exceedingly great. This results in a localized heating which

speedily raises the temperature to a value sufficient to change to insulating litharge all the conducting peroxide in this minute path of the current flow in contact with the electrodes. The film consequently reseals, stopping the further flow of dynamic current. This action is so rapid that its duration cannot be measured on an oscillograph giving 2000 cycles per second; that is to say, the action of resealing occurs in less than one four-thousandth part of a second after the excess of lightning voltage has ceased. These spots of insulating litharge plugs are visible on the surface of an electrode.

This film can be made of litharge itself, as well as any of the insulating materials above named. Metal plates may be inserted in any of the well-known lead electroplating solutions, and thus a thin lead peroxide film (measuring a few hundred thousandths of an inch) formed. By proper heating this will be changed to litharge and this form of electrode can be used. Peroxide may also be sprinkled over any metal plate and the plate heated, which will reduce the peroxide to litharge. Again, the metal chosen for the electrode itself may be lead, and if heated in the air a thin film of litharge will be formed on the surface. Again, an aluminum electrode may be put in any of the common electrolytes, and a thin aluminum film be built up. This may be used with the peroxide powder. Of these methods of forming the film the most preferable is by dipping in varnish or lacquer highly burnished surfaces of brass, steel or copper, and is consequently used in the commercial arrester. The ohmic resistance of the arrester during discharge is quite low (less than 1 ohm per cell). Thus, when the insulating film is punctured the arrester offers very slight impedance to the flow of energy at abnormal voltages.

There is a certain range of voltage necessary to pierce any given insulation, the exact value depending not only upon the thickness of the insulation and its dielectric strength, but also on the relation of the dielectric spark lag to the duration of the super-spark potential and the frequency of alternations of the transient surge.

If an arrester is to give protection to insulation in shunt with it, the arrester must relieve the abnormal electric pressure before damage is done to the insulation. Although tests are frequently made with the arrester and the insulation it is to protect in parallel, a more convenient method has been standardized and is known as the equivalent sphere gap test. Both the insulation and the arrester are compared by comparing each to the equivalent sphere gap.

The equivalent sphere gap of the oxide film arrester may be analyzed, as in other cases, into separate and distinct parts. First, there is the equivalent sphere gap of the main gap in series with the cells. Second, the equivalent sphere gap to initiate a discharge through the insulating film on the plate surface of the cell. Third, there is the equivalent sphere gap of the resistance drop of the current discharging through the powdered peroxide in its path. Fourth, there is the equivalent sphere gap of the inductance of the arrester.

Commenting on these factors in their relation to this arrester, the main gap is itself a sphere gap which has the fastest spark of any practical gap. The gap setting, like that of the aluminum arrester, is only slightly above that of the normal voltage of the circuit.

The equivalent sphere gap of the film is several times greater than the thickness of the film because solid material has a greater dielectric spark lag than air, but with this multiple of the thickness of the film the equivalent sphere gap is still low. Since peroxide is a good conductor, the series resistance in the path of the discharge is insufficient to give an undesirable voltage drop. As to the inductance of the arrester, it has a minimum value due to the fact that each cell is only 0.5 in. long, as shown in Fig. 1, and these cells are placed one on top of another. In other words, the total length of the arrester (which constitutes the inductance) is short as compared to the necessary length of conductor from line to earth.

Comparison of the "Oxide Film" with Well-Known Arresters

The earliest form of non-electrolytic film arrester was known as the dry aluminum arrester. It

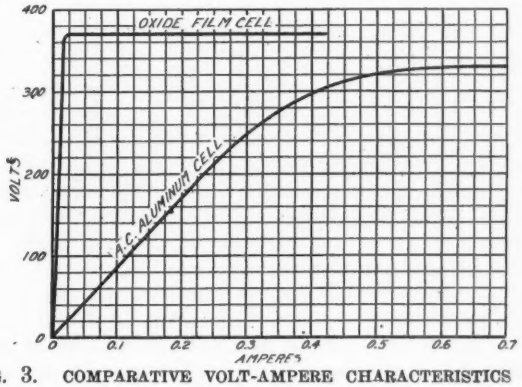


FIG. 3. COMPARATIVE VOLT-AMPERE CHARACTERISTICS OF OXIDE FILM CELL AND THE A. C. ALUMINUM ARRESTER CELL

was a direct attempt to utilize the dry film which forms on the surfaces of pure aluminum immediately after it comes in contact with the oxygen of the air. The hydroxide film is easily formed in electrolyte and on drying becomes a dry film which gives sufficient action to prevent a discharge up to a given critical voltage, depending upon the thickness of the film. The film can also be formed by a spark or arc of a conductor in contact with a plate. Naturally this conductor should be of a non-metallic nature. In the earliest form tried, powdered carbon was used mixed with dioxide of manganese, which gives a liberal supply of oxygen at the heated point.

One of the objects of the development of this arrester was to decrease the cost of manufacture, and it was found with the new principle involved in the oxide film arrester, where the powder furnishes the film rather than the plate, that the aluminum could be replaced by a cheaper metal, such as steel, and, as already described, the initial film known in the early stages of development

as the "paint skin" type could be furnished by a layer of varnish. On first sight, knowing the extreme thinness of the hydroxide film on wet aluminum cell, it might not seem that the dry cell would give the same general characteristics as the wet cell. But a comparison of the volt-ampere curves shows the same general characteristics. For alternating-current voltages of 300 v. average per cell the current in the dry cell is of negligibly small value up to 40 milliamperes. The power factor is nearly unity and the current flow is due to very slight leakages through the films. In the case of the aluminum electrolytic cells there is an equivalent condition, the direct-current leakage current of the order of one milliampere being due to leaks through the hydroxide film. In the alternating-current aluminum arrester the leakage current on the plate area used is much greater, due to the destructive action of the alternating current on the hydroxide film. Furthermore, the wet cell with its thinner film is a condenser of appreciable capacitance which takes a charging current of about 0.5 amp. at 60 cycles. When the voltage reaches a certain critical value which is between 300 and 400 v. for the wet aluminum cell and between 300 and 500 for the oxide film cell (or higher if the paint film is made thicker) the current is allowed to pass freely through the cells, limited only by the ohmic resistance of the cell independent of the film. Since the oxide film arrester has no dissolution of the film, as occurs in the wet aluminum cell, charging is not only unnecessary but undesirable. This extends the use of the oxide film arrester to localities where there are no attendants.

Although the wet aluminum plate becomes frosted to an appreciable thickness by the passage of current in long use, the actual thickness of the film, as represented by the critical voltage, is not changed. In the oxide film arrester, however, the film less than one 1 mil thick (0.025 mm.) initially thickens up by the addition of successive spots of litharge for each successive discharge. This represents the wear on the arrester and limits its total life. Figure 3 shows comparative volt-ampere characteristics of the oxide film arrester and the alternating-current aluminum arrester. Since both of these arresters have a leakage current which wears the plates of the cells when alternating current is supplied, it is necessary, as previously stated, to place a spark gap in series with the cells. This spark gap is set at a value slightly above the normal potential of the circuit so that nothing but abnormal voltages will cause a discharge.—General Electric Review.

Synchronous Motor Compressor Drive

IN A paper before the A. S. R. E., Truman Hibbard shows the advantages of the synchronous motor where electric power is used for driving ammonia compressors. The same arguments apply in the case of air compressors.

Synchronous motors have an efficiency, at 100 per cent power factor, 10 to 20 per cent greater than that of induction or direct current motors, and the efficiency remains high even down to ¼ load.

By using the new type of compressor adapted for high speed, direct connection may be had, with a resultant saving in space and power.

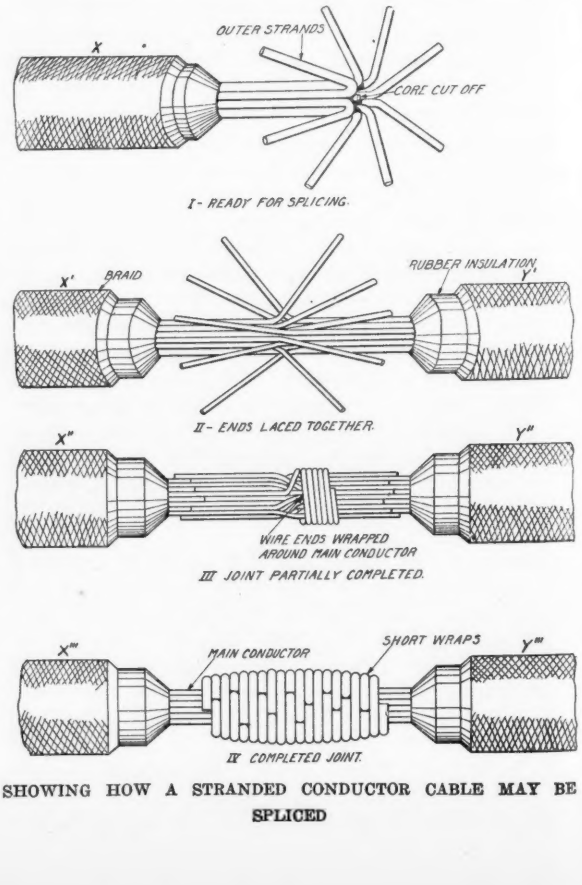
While it is possible to use a synchronous motor to correct for lagging power factor, it is done at the expense of efficiency of the motor; hence, in planning for compressor drive, it is better to use a constant exciting current fixed to give 100 per cent power factor of the motor at full load. The power factor will be slightly less than 100 per cent when the motor is underloaded, but the loss in rheostat resistance will be eliminated and the control system simplified. The power factor from 50 per cent to 125 per cent of rating will not change over 10 per cent.

Synchronous motors are now designed so that they may be started as squirrel cage induction motors, brought up nearly to synchronous speed in this way, and then speeded to synchronism and locked in step by sending a small exciting current into the field windings. It is necessary, however, to know how much flywheel torque has to be overcome on the compressor, and have the motor designed to take care of this at starting without drawing excessive current from the line.

Splicing Stranded Conductors

By R. J. Bennett

ONE very good method of splicing stranded conductor is that shown herewith. After the wire has been "skinned" it should be scraped or sand-



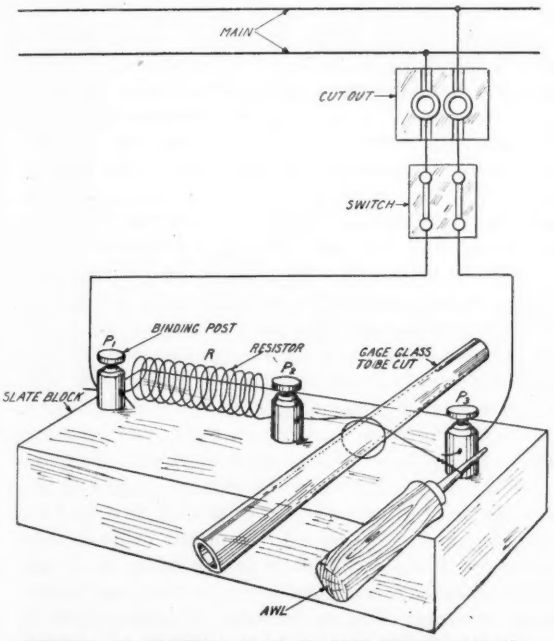
SHOWING HOW A STRANDED CONDUCTOR CABLE MAY BE SPLICED

papered until bright. Then the core should be cut out as suggested in I. The outer wires are then bent back into position and the two ends of the conductor to be spliced are laced together as delineated in II. Then each of the free ends is twisted and turned around the main conductor as shown at III. The completed joint will appear as shown in IV.

Cutting Gage Glasses

By L. M. Crowell

A GAGE GLASS can easily be cut by filing a nick in it or partially around it and then breaking it off at the nick. But a neater, cleaner break can be made by the electrical method, which is shown in the accompanying sketch. The arrangement suggested is simply one for heating the glass tube at the location at which it is desired to "cut" it. The heating is effected electrically. R is a resistance for limiting the current through the wire wound around the glass. Frequently a simple water resistance comprising a glass tumbler with some salt water in it and two copper-wire electrodes can be used to advantage instead of the wire resistance. The current through the wire should be of such intensity that it heats it to a red heat. A few



METHOD OF CUTTING GAGE GLASSES ELECTRICALLY

experiments will probably be necessary before the proper amount of resistance (P_1P_2) to insert in series with the wire can be determined. In cutting the tube, wrap the wire tightly around it at the location desired, draw it taut with a small brad-awl lever, A, using binding post P_3 as a fulcrum, and permit the current to flow for a few seconds. Then immediately thrust the glass in a vessel of cold water, and it will, if the manipulation is correct, break at the desired location.

Fuel Administration Helps

Letters Sent to Power Plants Under Jurisdiction of Administrative Engineer of Illinois

IN the Nov. 15 issue were published the first two letters of a series being prepared and sent out in weekly installments by Joseph Harrington, Administrative Engineer for Illinois. Below are given two more letters of the series which should be of aid to many in improving their plant efficiency.

3RD GENERAL LETTER

Directions for Operating Hand Fired Boilers

If these instructions are followed, the operation of boilers will be made easier and fuel will be saved.

Blowing Flues and Similar Work: Blowing and scraping of the fire surfaces of boilers should be done at a time when it will least interfere with the work of attending to the fires. If the fireman is compelled to blow flues in the morning when he should be giving his best attention to the fires, economy will suffer.

Number of Boilers to be Kept in Service: The smallest number of boilers that carry the load should always be employed. With those plants having a variable load, with a peak occurring at some period, the day should be started with the smallest number of boilers in use that will carry the load, and additional boilers should not be fired until needed for additional load. This is a matter that should have the closest attention and be carefully studied, to see how late boilers may be started without being short of steam. Just as fast as the load goes off, boilers should be dropped out of service and banked.

Method of Firing: In using mine run or lump coal, the lumps should be well broken up. With screenings or the fine portion of mine run, the coal will cake, and these caked masses should be carefully broken on the top after the cake has formed. This should be done with a light rake, but the fire should not be stirred or poked. Under no circumstances should the slice bar be run under the fire to free it. If the fire is dirty, it should be cleaned. If shaking grates are used, they should be shaken frequently, as this will remove the ashes, making a better fire and lessen fire cleaning. The coal should be evenly spread over all the surface of the fire, giving special attention to the sides and corners, always maintaining a good strong hot fire. While a good fire bed should be maintained, care should be taken that it does not get too thick.

Draft Control: A good strong fire may make too much steam if the draft is strong. Therefore the fireman should adjust the individual draft damper on each boiler as often as necessary to burn the fire at the proper rate.

When Furnace Should Be Fired: The time to replenish the fire by adding more coal is when the fuel bed has burned down below the normal, standard condition, the idea being to maintain at all times a uniform, economical fire. This proceeding is contrary to the usual practice in which the fireman waits until the steam falls and then adds more coal.

TO CONTROL STEAM PRESSURE: The steam pressure should be controlled by the draft, as the speed at which the fire is burned, or heat is produced, is dependent upon the amount of opening given the damper. Therefore, if steam is rising the damper should be checked. If it falls it should be opened; in this way the steam gage will show when to open and close the damper, and the appearance of the fire will indicate when the furnace should be fired.

NIGHT SERVICE: When fires are banked at night, draft should be cut off so that the bank will lie without burning. In the winter time, when steam is needed for heating, the same kind of fire should be maintained as in the day time, and the draft should be controlled in the same manner as during the day.

In carrying out this program, the use of unnecessary boilers in service, which only result in burning up coal without its being of benefit, will be eliminated, an economical fire will be maintained all the time the boiler is in service and by controlling the draft the fire will be burned only as required. When much steam is needed, dampers will be opened and the fire will burn faster, requiring more frequent replenishing to maintain the standard, uniform condition. When less steam is demanded, dampers will be correspondingly closed, the fire will burn more slowly and require less frequent coaling to maintain a good uniform condition. In this way an economical fire will be maintained at all times, and it will be burned at the rate required to supply the steam needed. The steam gage will show when to adjust the dampers and the appearance of the fire when to supply more coal.

REMEMBER: Always keep an even fire. The rear of the fire burns fastest. Look out for holes. Don't pile the coal up in the doorway, so you cannot see the fire. Use the boiler damper freely, that's what it's made for.

Illinois expects every man to do his duty.

Adapted from contribution by A. Bement.

GENERAL LETTER NO. 4

THE RATE OF COMBUSTION

THE RATE of combustion per unit area of grate surface has a very great effect on the efficiency of the furnace. Boiler tests will bring out the facts that every boiler and furnace has a point where it is most economical and this point is affected more by the rate of combustion than by the boiler itself.

To secure high efficiency, therefore, there must be an amount of coal burned per square foot of grate surface per hour that will permit of the most complete burning of the fuel with the least amount of ash pit loss or excess air.

In the state of Illinois, where chain grates are to be found in abundance, the conditions are substantially as follows: Chain grate coal is usually classed as screenings or nut and slack. Generally speaking, coal that passes through screens having a 2-in. round hole is the coal classified as above and usually purchased for chain grate use. This coal will have anywhere from 20 to 40 per cent of nut in it over half inch size.

Reference to the draft gage connected to the furnace will show that in the great majority of installations there is a draft equal to 1/10 to 3/10 in. water columns with an average probably around 2/10 in. With modern settings, where the value of adequate draft was appreciated by the plant designer, higher stacks exist and the average furnace draft is usually nearer 3/10 in. With this type of stoker it is possible to burn between 25 and 35 lb. of coal per square foot of grate surface per hour. A rule which holds fairly well is that you can burn 10 lb. of coal per square foot of grate surface per hour for each 1/10 in. draft in the furnace. This holds very closely between 20 and 35 lb.

Under these conditions, as will be explained in greater detail in my letter on gas analysis, 12 per cent of CO_2 at the boiler damper is about the maximum desired. Assuming that this is the ideal condition, it will be found that the rate of combustion has a very marked effect thereon. For the proper burning of coal, a fairly high temperature in the furnace is desirable, which cannot be obtained unless there is a brisk fire and consequent generation of heat at a rapid rate.

When the rate of fuel consumption per square foot on the chain grate stoker drops below 12 or 15 lb. per square foot, it is more than likely that there is a large loss of combustible. The first loss will be due to unburned carbon in the ash pit and the second loss will be due to unburned hydrocarbons in the stack gases. Another loss which could properly be included would be the excess air which could enter the furnace through the rear or thin portion of the fuel bed. This latter frequently occurs in conjunction with the second, especially in those types of furnaces where the mixing effect is deficient.

There is under these circumstances very sluggish combustion and the fuel is inclined to burn out unevenly. The stoker is operated at a low rate and the fuel remains on the grate surface a long time. Holes will develop or the rear of the fire will become very thin. If the stoker is operated fast enough to carry the fire back to the rear of the grate, loss in the ash pit is almost unavoidable. Under these conditions, very careful attention to the damper should be paid in order to adjust as nearly as possible the draft and the rate of stoker feed to the rating desired. Where more than one boiler is in service under these conditions of low capacity, it is usually found more economical definitely to bank one boiler and carry the entire load on the other, obtaining from it the maximum efficiency possible and burning just as little coal in the other furnace as possible.

Considering the other extreme of high rating, it is a fact that the efficiency of the boiler and stoker drops off very rapidly after a certain point is reached. This point is reached when the maximum draft is applied and no more coal can be completely burned. With many installations, this is reached when about 35 lb. per square foot is consumed. Any attempt to feed more coal under these conditions would simply result in burning off the combustible volatiles before dumping most of the fixed

carbon into ash pit. This involves heavy waste, and if this condition persists for more than a short time put another boiler in service.

Much of the foregoing applies equally to hand fired furnaces, only the rate of combustion practical to develop is somewhat less. Assuming the same general kind of fuel hand firing usually reaches its maximum at 25 to 30 lb. per square foot, and unless draft conditions are excellent, 25 lb. will be the limit. The maximum is somewhat less than in the case of the chain grate owing to the difference in the character of the fuel bed and the difficulty of filling the holes in the fire as they develop. It is, however, considered possible if proper care is used in keeping the fire even, to burn as low as 10 lb. of coal per square foot per hour with reasonable economy.

Inasmuch as other stokers of natural draft type follow along the general lines of the chain grate stokers, so far as rates of combustion are concerned they will not be mentioned here in detail. The underfeed type of stokers is in a separate class on account of the use of artificial draft. It is felt that in Illinois the hand-fired and the natural draft stoker-fired plant will include the large majority of all installations.

During the week devoted to the study of this matter, and especially in hand fired plants, I urged you to make an analysis of this situation by finding out the total amount of active grate surface under each boiler and weighing the coal to each boiler for a period of not less than one day. Keep a careful record of the furnace draft and of the coal weighed to each boiler by hours so that you can plot a curve for each boiler showing the coal consumed each and every hour on the basis of pounds of coal per square foot. See how closely this comes to the general principles laid down as above. Make this a matter of record in the boiler room record book for future reference.

Storing Cold

Holdover Brine Freezing Tank for Cooling Rooms During Shutdown Periods

FOR a refrigerating plant where the full capacity is not required to cool the rooms, a considerable saving can be made in the power used by running at full capacity for part of the time, storing the excess refrigerating effect, and releasing it to the rooms during the off period, while the compressor or ammonia liquor pump is shut down.

The old reliable brine tank is a common means of doing this where the capacity to be stored is not great; but it requires a brine pump to be in operation at all times. Such a tank may be used to carry a peak load on the system that is greater than the capacity of the refrigerating machinery, to hold the temperature of the rooms during a temporary breakdown, and to reduce the space for cooling coils in the rooms, thus increasing the space for storage of goods.

The brine tank serves, therefore, much the same purposes as a storage battery in an electric plant.

A second arrangement for storing cold is a series of hold-over tanks, one in each room, containing a concentrated solution of calcium chloride brine. This brine is cooled down by the excess capacity of the plant to about 20 deg. F., and when the machinery is shut down, heat is absorbed by this brine whose temperature gradually rises until it is again necessary to start the machinery. This serves the same purpose as the brine tank, but avoids the use of a brine pump. It occupies, however, considerable space in the storage rooms.

In a paper before the Milwaukee members of the A. S. R. E., Ernst S. H. Baars has described a modification of this latter system that has several advantages claimed for it. The following facts are abstracted from a report in the A. S. R. E. Journal.

Frozen Brine

Instead of using a strong calcium brine, Mr. Baars uses a weak solution, and freezes it during the excess capacity period. During shut-down the brine-ice melts and increases in temperature up to the point where it is no longer effective as a heat absorber, when the machinery must again be started.

Calcium chloride is used instead of common salt because it does not form crystals, but remains in a more finely divided condition, hence more readily re-enters solution during the thawing process.

Advantages claimed for this system are: That the volume of brine tank is only 1/7 that for a concentrated brine, leaving the other 6/7 for cooling coils or goods. The construction of the room can be lighter because of less weight of brine carried. Calcium chloride needed is about 1/11 that for a tank of concentrated brine to give the same storage of cold.

As an example, a room to be held at 32 deg. F. is taken. The ammonia will evaporate at about 0 deg. F. under a suction pressure of 15 lb., and the weak brine will be of 15 per cent calcium chloride to freeze at 12 deg. F. When freezing, crystals will form carrying 1/3 their weight of water, or 20 per cent altogether, of the solution, the balance, 80 per cent, being formed as water-ice. This ice, after freezing, will be cooled to about 5 deg. F. by the ammonia coils.

When thawing, a pound of the brine will then absorb heat as follows: With specific heat of the ice taken as 0.5,

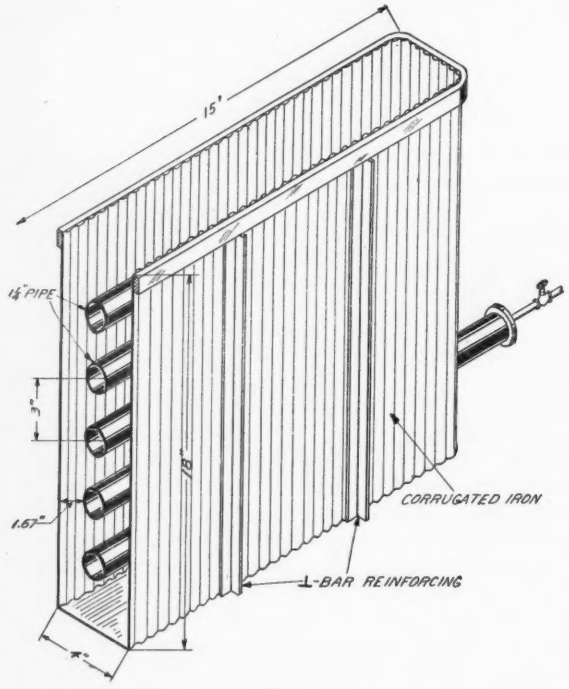
Heating ice	$0.5 \times (12-5) =$	3.50 B.t.u.
Thawing water	$0.80 \times 143.5 =$	114.80 B.t.u.
Heating brine to 25°	$0.80 \times (25-12) =$	10.40 B.t.u.
Total		128.70 B.t.u.

This is about nine times the heat that would be absorbed by 1 lb. of concentrated brine working between the same temperatures, i.e., 5 deg. and 25 deg. F., but in practice the ratio will be about 7 to 1 for equal volumes on account of space occupied by coils.

Tanks for the frozen brine system must be of special design, so that the brine will all be close to the coils and freeze rapidly, keeping the crystals in the ice instead of allowing them to settle out. Thus they will be in position to go into solution rapidly as the temperature rises above the freezing point. Also the shape must be such as to allow for expansion to avoid bursting during the freezing process.

This is accomplished by using a thin tank, 4 in. wide, 24 in. deep and 9 ft. long, with walls of corrugated sheets. In this tank is a coil of 1¼-in. pipe, 7 pipes high and 8 ft. 6 in. long. Ammonia is passed first into this coil, then to the cooling coil in the air of the room.

In determining the tank dimensions, three points must be considered: There must be surface to absorb



SECTION OF HOLDOVER BRINE TANK

adequately the heat entering the room through the walls; there must be sufficient volume of brine; it must be possible to freeze the brine during the time that the machine is running. If the first condition is fulfilled, the other two will, generally, be taken care of. The surface may be calculated on a basis of 1.5 B.t.u. absorbed per hour per degree difference between room and freezing temperature of the brine. A pound of brine of strength to freeze at 12 deg. F. will reject or absorb 114.8 B.t.u. when freezing or thawing; this determines the volume needed, the weight being 70 lb. per cu. ft.

The coil surface needed will be found by allowing 1.5 B.t.u. absorbed from the brine per square foot per hour per degree difference between freezing temperature of brine and that of ammonia in the coil. And the hours time to freeze the brine will be found from the formula:

$$H = 28 \times t^2 \div (T_b - T_a)$$

Where H is time in hours, t is greatest thickness of ice in inches, T_b is temperature of brine and T_a of ammonia in degrees F.

For a holdover tank to take up 21,720 B.t.u. in 14 hr., room temperature 35 deg., ammonia temperature 0 deg. at a pressure of 15 lb., brine of freezing temperature of 12 deg. and running time of 10 hr. for machinery, the dimensions work out to: Length, 15 ft.; width, 4 in.; height, 18 in.; coil, 73 ft. of 1¼-in. pipe arranged 7 pipes high at 3-in. centers.

The required surface is 44.9 sq. ft. and weight of brine 189 lb., or 2.7 cu. ft. The tank gives 46 sq. ft., and with the coil in place allows 4.9 cu. ft. of brine. The greatest thickness of ice to be frozen is 1.67 in., which works out to a freezing time of 6.54 hr., giving ample margin during the 10-hr. running time.

Fuel-Saving Records

RECORDS from Worcester, Mass., as to fuel savings effected under the program of the Fuel Administration give reason for satisfaction and food for thought. With such results, the question arises at once: Why has it not been done before? Both as a conservation of resources and a saving in production expense it would have been well worth while. It is safe to say that never again will coal be looked upon as a material to be wasted thoughtlessly.

Some representative records are: Reed & Prince Mfg. Co., from May to October, 41.7 per cent in boiler room; 17 per cent in annealing room. Norton Co., 18 per cent in coal; 24 per cent in power, "due mainly to help of employes and foremen." Crompton & Knowles rearranged motors and saved 63 hp. Spencer Wire Co., rearranged motors and cut out unnecessary lights, saving 3500 watts and 37 T. of coal a week. Reed-Prentice Co., reset boilers and saved 66 T. of coal in September, 1918, over September, 1917. Graton & Knight Mfg. Co., covered steam piping, regulated temperature, repainted ceilings and walls and placed switches for turning out lights not in use, thus avoiding increase of fuel consumption with largely increased plant.

These savings have been made, for the most part, by the obvious methods of covering piping, lining up shafting, turning off lights, saving exhaust steam, stopping leaks, rearranging loads to keep motors working efficiently, keeping records and comparing with results that ought to be obtained, cleaning heaters and boilers and keeping them clean. All these things ought to be done all the time in every plant, and the results obtained show that it pays.

In some plants damper regulators, coal weighers, steam meters, blowers, water meters, heaters and traps have been installed, with savings that show a remarkable return on investment.

There is no mystery in fuel saving. It is a matter of knowing where to find the leaks, how to stop them, studying changes that will give better efficiency, and then "going to it." No plant is so good that it cannot be better. The only question is, "How much better results can my plant be made to show?"

Effect of Armistice on Industries and Labor

General Outline of Adjustments the Federal Government is Making; the Effect on the Prospects of Labor, the War and Non-War Industries, the Fuel Situation, the Possibilities of Commercial Development, the Status of War Contracts, the Shipbuilding Programs and Other Phases Affecting the Interests of Those in the Engineering Lines. By A. P. Connor, Special Washington Correspondent

VARIOUS war machines of all the countries, directly or indirectly engaged, have been put into a condition of peaceful inactivity as the result of the signing of the armistice. This brings about a suspension in the provision of many supplies that would otherwise be needed, and many branches of the government become thereby inactive, and adjustment must be made gradually to eliminate them, and yet have them ready to bring back into active use, in case conditions require it.

Now, although peace will be the result of the negotiations arising out of the armistice, nobody knows when that will result or even what the actual terms will be. It is safe to predict that it will be next fall before the actual peace is brought to a complete condition for promulgation. In the meantime, however, there will be no war, and there is every inducement to all, to proceed with the fullest hope and activity towards the development of business and the aims of peace.

The Prospects for Manufacturing and Industrial Interest

It will be foolish for manufacturing interests to become alarmed at the new condition arising from the signing of the armistice, and especially when every arm of the government is offering such ample encouragement at this time, as well as advice. There is still a large sum of money to be spent by the government. There are still great needs to be supplied in other countries, by the industries of this country and its labor. There are many things to be made for the needs of this country, that have been suspended, or partially suspended, during the interval of belligerent stress that has just passed. There are still many government contracts to be completed and others to be let out. There are many new industries that can be developed in this country that have been overlooked in the past, and drifted to other countries, and we have many latent products and facilities that can be developed with advantage. There is further a let-up on restrictions by the government on all commodities that it restrained during the war, and this will enable all interests to proceed to its maximum ability. The country is also at an advantage in that it has learned many lessons in economy that will be of value to industry.

The Prospects of Labor

Are your chances in your job or at your work less now than they were a few days ago, when industry was in full blast for the needs of the war? They are just as good, in fact are better. If the government also continues its good offices in causing agreements to be made justly, without the troubles and losses of strikes, it will do labor continued benefit and the country great good. There will be a release of soldiers from time to time from active duty, so they may come back to the various fields from which they were taken; such, however, will not affect the industrial fields of labor to its disadvantage, but will assist it in many ways. There are also great possibilities of the cost of living being reduced, and there are prospects of many new industries arising for which an increase in the demands for labor will be made.

Concerning the return of soldiers, there is no definite information available; but indications are that demobilization will take place slowly and will not be completely made for about 18 mo. or 2 yr., during which time certain supplies will be needed continually and will have to be supplied by American industry.

The Fuel Administration

The Fuel Administration is not out of existence, and will not be until peace is proclaimed, after which it will become a non-existing legal body and such duties and aims as it had, will be absorbed by other main governmental departments, but mainly by the Bureau of Mines. While the Fuel Administration is in existence, its attitude is one looking to the advantage of the United States. It has already canceled about 50 per cent of its edicts and there is every indication that it will complete the cancellation before the end of the month, and no industry will be held up on account of the Fuel Administration, from having its supply of fuel and the furtherance of its development. At the present time, there is an ample supply of bituminous coal, and this in spite of the epidemic and other conditions arising to interfere with the production of coal. As a matter of warning, however, it is well to call attention to the fact that manufacturers or householders should not use fuels carelessly or extravagantly, or they may find that their action will prove against their interests more forcibly than can be foretold at present. Should there be a strike in the coal regions or other catastrophe, a state of things may arise that may necessitate a return to further edicts and the policies outlined by the Fuel Administration for the war.

In the matter of anthracite coal, there appears to be a slight decrease over normal, in the supply, and a certain amount of conservation is desirable in these lines for the present.

In the matter of the zoning systems for the distribution of coals, the Fuel Administration will still keep its principles of economy in force, so that the fuel restraints will be as little as possible, until normal peace conditions return. The suggestion to all concerned, is to use

care and judgment in the use of coal and not waste it under any condition.

In the matter of coke, the supply is slightly less than the maximum demand industries have been requiring during the year, but under the new conditions there appears to be an ample supply, and in case of necessity, the supply can be increased by the greater use of transportation facilities that have been so taken up with the transportation of military supplies and equipment—which will be slightly lessened in the near future. A summary of the supply of coal delivered for all purposes for the year, indicates that 60 per cent has been delivered already and under the expected rate of delivery, the remainder can be amply taken care of.

The foreign transportation of coal is understood to be negligible, now that the armistice conditions exist. The countries needing a supply will be taken care of by other countries, and the main efforts of this country will be used towards the delivery of food and other essentials of living. These supplies will use up all our available shipping, and will permit the United States to do the most good to the world in general.

War Contracts

The question of war contracts is one that will be of interest to many industries, and one that divides itself into the needs of the various departments. The Navy Department will continue with a large quantity of its programs but those referring directly to training camps and aviation fields that were about to be built, will be stopped in their construction. All material needs outlined for the increase of navy yards will doubtless proceed without interruption. There will, however, be a decrease in the personnel of this department and tens of thousands of sailors or reserves will be permitted to leave the service after about a month. It is understood that work will be stopped on the great new nitrate plants for the Navy Department.

Shipbuilding Yards

The shipbuilding program will apparently be proceeded with as anticipated for the war programs, and if anything increased to take care of the merchant marine needs of the country and its future foreign commerce. There may be a decrease or practical elimination of large tonnage ships made of wood and concrete, but the steel ship program will be given the development that will be ample for the needs of this country and its foreign commerce. It is not believed that this country will go back into the past lethargy in the matter of a merchant marine, but will make the most of this feature, on which so much of this country's progress depends. Therefore all industries that have interests in the lines of shipbuilding outlined, have in prospect a 10-yr. or longer term of supplying and providing for their needs, and there should be after that an increase in the professions, trades and industries appertaining to the construction, maintenance and outfitting of merchant ships.

War Plants

It is understood on good authority that the President is considering plans for the establishment and appointment of a commission to keep these matters of governmental contracts in such a progressive state that they will not be stopped at all but rather evolved into something that will be of commercial value and advantage to the country. The commission will consider the plans for the changing or use of the great war plants into plants that can be used for other purposes and continue to keep people and labor employed and industry flourishing.

Suggestions to Factories Having Material Left on Hand

There are some factories that have or will have material on hand after the government has finished its dealings, and in such cases, it would be well to anticipate a use for the material or apparatus so that they can get into practical use. A little ingenuity may be necessary, but it will pay, and the country will benefit by it. Much material can be used for entirely different uses and arts than those for which they were originally designed or intended, and this principle of invention should be fully developed at this time where so much valuable material, machinery and apparatus is involved.

In some factories, the administrations offer a bonus to their employes who will find an active use for the material or apparatus that has accumulated on their shelves or stock yards. The idea of organizing suggestions and protecting all the industries of the country is being advocated by the American Chamber of Commerce; and the President, it is understood, is favorable to it, and actively co-operating to bring about the best industrial and progressing conditions, so that the country will be in a position to handle not only its own commercial needs, but also those of the parts of the world that need the products of our labor and industry.

As regards material that has been held back from various factories during the war period, it may be said that they will receive assistance from the War Industries Board if they will bring the matter properly before its attention, and it is within its practical scope to be of assistance. This ought to give a great impetus to all those lines which have been more or less held up for the past 2 yr., and enable them to proceed heartily into their future prospects, and keep their factories and employes going at full efficiency to make up for empty stocks that have arisen in their lines due to the non-production. Power plants should proceed with the idea of bright and prospective future, and every water power possibility made the most of at the earliest possible moment. There is every indication that everything of value that can be produced for a long time to come will be needed and used, and it is to the advantage of all to make this time in full accord for the demands of the future, which are going to be great.

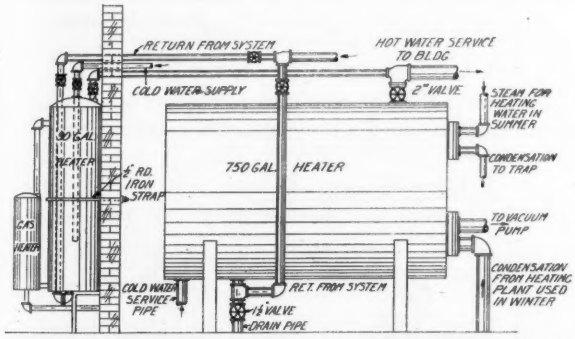
Besides the greater enjoyment during the 7 mo. of "daylight saving," it is estimated that a million and a quarter tons of coal were saved, or a value of at least $4,000,000, to say nothing of the labor required to mine and handle it.

Lower Cost of Hot Water

THE WRITER took charge of a large public building in which part of the equipment was a 750-gal. hot water heater for the purpose of serving the public with hot water service in lavatories throughout the building. During the winter months, the water is heated by circulating the return water from the steam heating system through this heater on its way to the vacuum pump. During the summer months, the water was heated by steam connections in the upper part of the same heater. During the month of July, 1918, it cost $132.99 for heating the water by the above means, for one month.

This was considered altogether too expensive, therefore the writer proceeded to see what arrangements could be made to economize on the cost of heating water. We purchased a 90-gal. tank and a gas heater of sufficient size to heat the required amount of water, at a cost of $85 installed. The heater was put in service about Aug. 1 and our gas bill for heating water for the month of August, 1918, was $16.32. If steam had been used, the bill would have been about equal to July, 1918, which was $132.99. Therefore, the heater paid for itself and left a balance of $21.67 during the first month of its use. The sketch herewith shows how the necessary connections were made.

C. S. TOMPKINS.



METHOD OF CONNECTING UP WATER HEATER

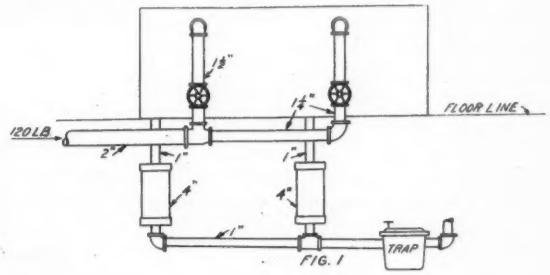
Solving a Condensation Trouble

A COTTON DRYER piped as shown in Fig. 1 had always given trouble inasmuch as the rated capacity could not be gotten out, although the speed was that recommended by the builders and the steam pressure in the coils 120 lb. gage.

The builder's man examined it and could not find anything wrong and the owner was about to replace it with a larger one.

The engineer looked it over when searching for steam leaks and found that there was 2700 sq. ft. of 1-in. pipe in the two coils with fans to force the air over the coils. The total heating surface was divided into two coils. The engineer figured that the first section, where the wet cotton came in, would condense about 0.7 of the total steam used and the last section the remainder, figuring the condensation on the basis of 3 lb. per sq. ft. of surface per hr.

Turning to the table of capacities of the trap he desired to use, the engineer selected the proper sizes and in due time had them connected, as shown in Fig. 2.



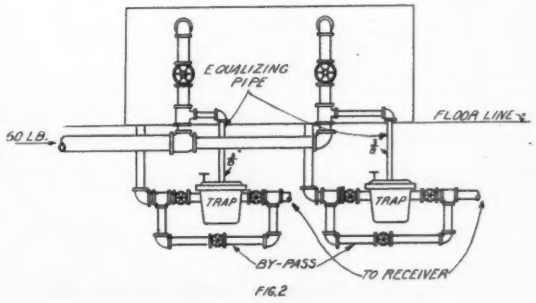


FIG. 1. ORIGINAL PIPING OF COTTON DRYER
FIG. 2. REVISED PIPING OF DRYER

Covering the piping on inlet and outlet of the dryer enabled the operators to get an increased capacity of 10 per cent over the builder's rating, and the steam pressure was reduced until it was found 60 lb. gage gave the desired results.

These two traps were piped to discharge into a receiver in the boiler room, the condensation then going into the boilers from a return trap, the returns from all over the plant were connected into this receiver in place of the open tank formerly used and the coal consumption reduced 50 per cent in summer.

The slashers were piped as shown in Fig. 3. In the two cylinders on each machine, scoops were soldered to the shell and piped to the outlet and then connected to a trap as shown.

There was trouble from the scoops getting loose and when in place the condensate would accumulate so it was necessary to run with the trap bypass open.

The engineer decided that a better way to secure the scoops was to rivet copper bands to the scoops and secure the bands with machine screws onto the stiffening hoops in the cylinders. The piping was changed as shown below in Fig. 3, with the two additional traps on each machine, all of which discharge into the receiver mentioned above. Here again the steam pressure has been

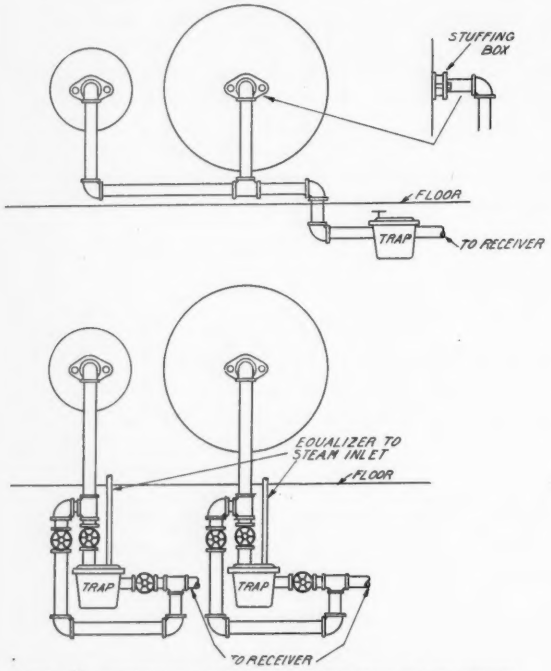


FIG. 3. ORIGINAL AND REVISED PIPING OF SLASHER

reduced from 15 lb. on the cylinders to 8 lb., all of which is in direct line of fuel conservation.

RECEIVER.

The Relation of Good Lighting to Safety

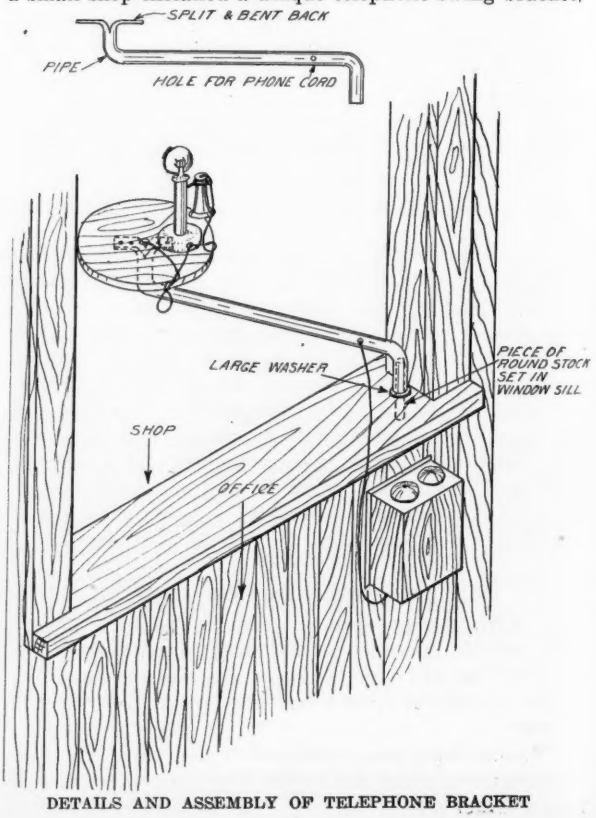
SINCE THE workmen's compensation law was enacted and insurance companies assumed the employers' liability, the accident investigators of the insurance companies have proved that many accidents theretofore ascribed to "carelessness," "falls," etc., are directly due to inadequate lighting. The public is more or less familiar with curves showing the increase of the accident rate with the decrease of the number of hours of natural light each day throughout the year. Such curves strongly indicate that artificial light influences the safety of industrial workers, but they do not specifically prove it; it has remained for the insurance companies to gather the evidence in a manner which leaves no doubt. With, then, highly specified organization, which seeks to get at and remove the cause of industrial accidents, they have indicated poor lighting as causing directly and indirectly an enormous number of deaths and maimed and injured bodies. A well-lighted factory is given preference for group insurance and a poorly-lighted one is penalized from 2 to 5 per cent of the premium, and insurance is made only on condition that the lighting is improved. Insurance companies have an indisputable argument for better lighting, which is based upon experience.

As an instance in point, the State of Wisconsin has, through its Industrial Commission, accumulated data from which it is estimated that for the year 1915 sufficient time was lost in Wisconsin factories, due to industrial accidents, to be equivalent to 6300 workmen being unemployed for a whole year. The salary value of these men for that time is $2,922,000. During that year workmen received $974,000 as compensation for injuries. If we agree that of the total of this loss, amounting to $3,896,000 one-quarter thereof can be attributed to poor lighting, then we have a loss from bad lighting of approximately $974,000. No more striking illustration could be given of the actual value of good illumination, and how it pays insurance companies as well as mill owners to avoid accidents by the provision of ample light.

MARK MEREDITH.

A Convenient Telephone Bracket

TO PERMIT the shop foreman to use the office phone, a small shop installed a unique telephone swing bracket,



DETAILS AND ASSEMBLY OF TELEPHONE BRACKET

as shown in the sketch. It is installed in the window between the office and shop. The construction is quite simple. A piece of board was cut out in a true circle and secured to the swinging arm, which was made of pipe. This is shown in detail.

A short piece of round stock of just the size that would fit the inside of the pipe was set partly into the window sill. An iron washer was fitted over this, and then the pipe arm set on the pivot, as indicated. The telephone cord passes through the inside of the pipe.

C. H. WILLEY.

Coal Pile Ventilators

CONSIDERABLE trouble was recently experienced at the steam plant of a western Wisconsin central station company with the frequent firing of a coal pile containing about 1200 tons of Illinois screenings and having dimensions of approximately 60 by 80 ft. and a maximum height of 25 ft. Each time a fire was in evidence it became necessary to put a force of men at work to dig out the hot spot, with the result that much time and money were expended.

To eliminate the trouble, 12 old 4-in. boiler tubes, each 18 ft. in length, were secured, and after one end

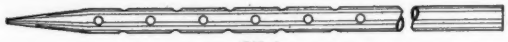


FIG. 1.

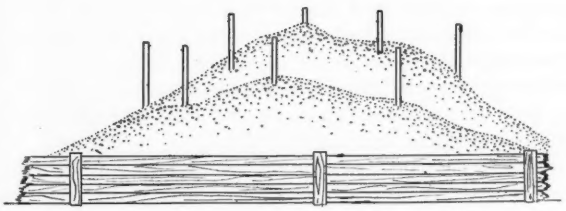


FIG. 2

FIG. 1. VENTILATOR MADE OUT OF AN OLD BOILER TUBE
FIG. 2. METHOD OF PLACING VENTILATORS

of each was pointed, as shown in the accompanying illustration and ¾-in. holes drilled every 12 in. and spaced in the manner indicated, the tubes were driven into the coal. Spacing and location were according to the height of the pile and the points at which firing most frequently occurred.

After the installation of these ventilators, no further trouble was experienced.

Effect of Change of Frequency on Induction Motors

ON PAGE 884 of the Nov. 1 issue of Power Plant Engineering, Mr. Berkeley does not make any statement as to what voltage one should use when changing from 25 to 60 cycles.

In general, the voltage can be increased directly as the frequency; a 25-cycle, 220-v, 750-r.p.m., 5-hp. motor could be run at 60 cycles, 528 v. 1800 r.p.m., 12 hp.

It is not likely that 550 v. would injure the machine, but 440 v. would be the better connection. A 60-cycle, 550-v., 1200-r.p.m., 6-hp. machine could be run on 25 cycles, 220 v., 500 r.p.m., 2½ hp. with good results, the main thing being to keep the current or heating within the specified limits.

Therefore one can see that the faster one runs the machine the more the horsepower output, directly as the speed.

The magnetizing current will increase rapidly after passing about 10 per cent above normal voltage; therefore if a 60-cycle, 220-v. induction motor is run on 25-cycle, 220-v. circuits it will take a very high current due to the high saturation of the iron. F. B. K.

Care of Cup Leathers

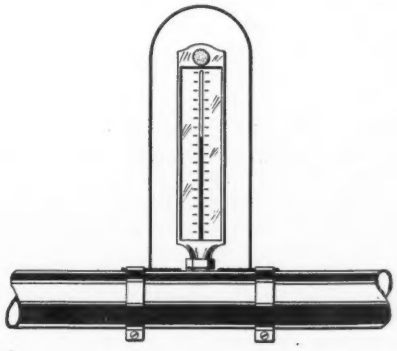
IN REGARD to F. P.'s inquiry in Nov. 1 issue about the care of cup leather when not in use, I will say that if he will remove them when the factory shuts down and place them in warm neatsfoot oil (about 160 deg.) for a few hours, the moisture will give place to the oil, which is an excellent leather treatment. After the oil bath wipe the leathers off and put away in a dry cool place. Castor oil is a good substitute for neatsfoot oil.

R. PORTER.

Thermometer Guards

ONE OF the most frequently encountered causes of incorrect and inaccurate readings of thermometers is that the thermometer has been jarred or jolted; especially is this the case where the instrument is located where it can be knocked or can catch on the clothing of passersby.

Where a thermometer is installed in such a location



METHOD OF APPLYING THERMOMETER GUARD

it is good policy to provide a guard. The writer has made several simple guards, as shown herewith. This is made of a bent piece of light sheet iron with two or three clips at the bottom by means of which the shield may be attached to the pipe by means of bands. Of course, to be of any value the guard should be fastened independently of the thermometer, so that the latter is entirely protected from jars and shock.

M. A. SALLER.

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The New Size

Necessity knows no restrictions. In the interest of conserving fuel used in manufacturing and transporting paper, and to save chemicals needed for making explosives, the War Industries Board some time since ordered a reduction in the use of paper by all publishers, to considerably below the weight used during past years.

Those publishers who have been sending out a large number of sample copies or who have sent a considerable part of their circulation to news stands and allowed the return of unsold copies could easily reduce their paper use by cutting down on those items. But Power Plant Engineering, which has gone only to paid-in-advance subscribers, and on which no news stand returns are allowed, found itself in a dilemma.

As our readers know, the size of the paper has been increasing, due to the recognition of its value by the large interests and big men in the power plant industry. And its circulation has been growing, due to the help that readers have received from its pages and the real service it has given them. Power Plant Engineering was not willing to limit its help to the industry either by refusing subscriptions of those who wanted it or by decreasing the amount of reading matter in each issue.

One course only was left, to decrease the weight of paper, either by making it thinner or by using a smaller sheet. The War Industries Board set the maximum thickness that may be used, and it was about as thin as can be printed on both sides without having the print show through so as to be annoying. This left as the only recourse the use of a smaller sheet, and in order to give the same reading space as heretofore, this necessitated the narrower white margins.

The lessened white space in no way lessens the service or helpfulness of Power Plant Engineering, and our borders must go the way of non-essentials so long as Uncle Sam needs the coal.

The war is over, but paper has to be ordered a long time ahead, so that during the reconstruction period we shall still have to show this visible evidence of how far an ambitious military autocrat can interfere with the peaceable pursuits of men on the other side of the world, and of the co-operative sacrifices we have all been called on to make to help in winning the war.

Your Fuel Saving Campaign

During the past year, and particularly during the last six months, power plant managements throughout the country have been bending every effort to make savings in fuel. Their courses of action have been directed largely by the Fuel Administration, although in many cases the engineers have been given more liberal support, which has resulted in improvements leading to higher economy.

Those of our readers who have been able to make a saving are in position to pass their methods along, and should do so for the good of the country in general. Power Plant Engineering is anxious to do its share in distributing all information that will help to increase

economy, and at the suggestion of the Fuel Administration invites readers to send in contributions covering the three questions: What was done? How was it done? What results were obtained?

As many of the letters received will be published as space permits, but we wish to hear from every reader that he has done his share in the campaign of the nation to save coal. No saving is so small that it should be overlooked, for in some plants it may amount to a great deal. We learn of a plant where careful watch of the temperature of hot water tanks resulted in a saving of 5 tons of coal a day. In another, closing the main valve to steam-driven machines at night resulted in saving 25 lb. coal daily. In the letters department of this issue is described how a great saving was made by changing the method of heating house water in the summer time. The campaign which you undoubtedly have been conducting has surely resulted in some saving. Let us hear about how that campaign was conducted.

Home Heating Plants

During this winter of fuel readjustment, the power plant man, who has, of necessity, made a study of proper combustion conditions has an opportunity to render a public service of great value to his friends and neighbors.

In many sections of the country those who have heretofore burned anthracite coal in their homes must use soft coal from either eastern or western mines, and others who have used the eastern "smokeless" soft coal, usually loosely classed as Pocahontas, must get along with mid-west coals having a much greater per cent of volatile matter.

In general, the principles of burning bituminous coals to the best advantage are well understood in power plants. A considerable supply of air above the fire bed; that air as hot as possible before coming in contact with the volatile gases; thorough mixture of the air with the gases; keeping the temperature of the mixture above ignition point until combustion is complete.

With the large fire box, long flame travel and constant attendance of the power plant boiler, these conditions are readily attained if the fireman understands his business and attends to it. Light, frequent firing on alternate sides of the fire, keeping air holes covered, regulating the air supplied above the fire and keeping clinker out of the fire bed will almost certainly give good results if the proportions of the boiler setting, firebox and stack are within reason of right.

In the house heating plant the conditions are difficult. The firepot is small, draft probably not very strong, flame travel short and frequent firing is out of the question except for stores, where it must be done if any success at all is to be had. The problem is how to meet these adverse conditions so as to get the best possible results.

As to the chimney, it should be straight, smooth inside, free from obstructions and leaks, inside area at least as great as that of the smoke pipe, and extend well above any roof within 50 ft. of the chimney. If an iron extension is needed to bring it to that height, the extension should have an area equal to that of the chimney flue. Cracks or air leaks should be pointed up, and any openings into the flue that serves the heating plant, which may have been made for stores, heaters or fireplaces, should be closed air tight.

The smoke pipe should be as short and straight as possible, with a steady rise from smoke connection to chimney. It should extend into the chimney even with the inner surface and be cemented in air tight. Do not use the check draft in the smoke pipe. It makes soot in the smoke pipe and chimney. Control the draft by damper, ashpit door and slide in the firing door, keeping the damper at all times open as wide as possible consistent with regulation of fire needed.

For round firepots 18 in. diameter and over, and for rectangular grates, a wedge system of firing is best, allowing the coal to burn in from one side.

Shake the grate only until a few bright coals appear in the ashpit. Draw the hot coals to the front of the fire box in a wedge, heaping them up to the level of the firing door. Some ashes and partly burned coke should be left on the back part of the grate.

Wet the coal to be fired. Sized coal should have each piece well wet; run of mine should have the fine portion well moistened throughout, but should not be dripping wet. The wetting slows down volatilization and enables the gases to burn better in the space above the fire.

Fire the fresh coal into the wedge-shaped space at the back of the fire box, regulating the amount fired by the amount of heating needed. In any case, the fuel level should not be much higher than the bottom of the firing door, as space is needed above the fuel for burning the gases. Bright coals should be left uncovered next to the firing door for at least one-third the area of the fire pot. Leave the slide in the firing door open, the amount to be found by experiment to give the least resulting smoke from the chimney, until the fresh fuel is burned down to coke.

For round fire pot less than 18 in. diameter, where wedge firing is found impractical, the pyramid form may be used, but will require more frequent firing with smaller amounts of fuel to avoid making smoke.

Wet the fuel. Shake down the grate, level the top of the fire and fire the fresh fuel on the center of the fire in the form of a cone, leaving a ring of uncovered bright coals around the outside, so that the fire will burn from the edges toward the center.

Leave space above the fuel for the gases to burn, and regulate the firing-door slide as for wedge firing.

Handling any house heating plant successfully with soft coal requires study and experiment, as draft conditions and grates vary widely. In general, a sized coal should be used the same size as of anthracite. If mine run is used, break the lumps to the size of a fist, put these in the bottom and cover with fine stuff to a thickness needed to give the amount of fire wanted with the draft available.

You engineers whose business it is to know combustion engineering can be of great assistance by spreading a knowledge of these methods of firing among your friends, and by helping them to find the best way to handle their house heating plants.

Reconstruction Conference

CALLED BY THE CHAMBER OF COMMERCE OF THE UNITED STATES TO CONSIDER A PROGRAM FOR HANDLING PROBLEMS OF CONTRACTS, DISTRIBUTION OF RAW MATERIALS, EXPORT AND IMPORT LEGISLATION, MERCHANT MARINE, LABOR SUPPLY, PRICE CONTROL AND INDUSTRIAL COMBINATIONS, AND TRANSPORTATION DURING THE PERIOD OF READJUSTMENT TO PEACE CONDITIONS

THIS Reconstruction Conference of the Industrial War Service Committees has been called for Dec. 3, 4, 5 and 6 at Atlantic City. The sudden termination of the war has brought reconstruction to the front as the one important problem today facing business men and industries. In the congress at Atlantic City is offered the opportunity for industry to assume the leadership in dealing with those questions which primarily affect business.

On Dec. 3, the first day of the conference, the 350 war service committees meeting separately will take up questions of special interest to their own industries. At these meetings there will be formulated the policies of the industries represented by the committees and resolutions which individual crafts desire to present during the conference.

For the purpose of facilitating discussion and coordinating the ideas of the various industries represented the war service committees after meeting separately will gather together in 35 related groups. Afterwards these related groups will assemble as 10 major groups representing the 10 primary industries within the United States.

The 10 groups as defined for the purpose of the conference are as follows:

Food products.
Textiles.
Heat, light and power.
Metals and minerals other than iron and steel.
Iron and steel.
Wood and wood products.
Chemicals.
Leather.
Earthen products.
Industrial professions.

The 35 related groups, in which some changes will be made before the final program is approved, are outlined as follows:

Food production and exchanges.
Food conversion, milling, canning, meat packers' by-products.
Oil and oil products (animal and vegetable).
Coal and coke.
Public utilities.
Oil and oil products (mineral).
Gas motors, automobiles, engines and the like.
Steel and iron production, rolled and drawn.
Steel and iron products, fabricated or manufactured.
Steel and iron products, cast.
Machinery, tools and power equipment.
Hardware.
Building materials, except those otherwise specified.
Farm operating equipment—agricultural implements, fences, etc.
Non-ferrous metals, brass and alloys.
Gold, silver, precious and alloyed metals.
Wool and wool products.
Cotton and jute products.
Silk and silk products.
Rubber, saturated and coated textiles and allied products.
Lumber and products, except those specifically comprised in other related groups.
Wood-pulp and paper products.
Printing, engraving, lithographing and materials.
Office, store and bank fixtures, equipment and office devices.
Furniture.
Acids, heavy chemicals, miscellaneous and industrial chemicals, paints and pigments, artificial dyes and intermediates, tanning materials and natural dyestuffs.
Fertilizer and fertilizer chemicals.
Boots and shoes, harness and saddlery.
Tanning and leather raw stock.
Clay and clay products, such as brick, tile and semi-porcelain clay.
Sand, lime and stone cement (except when otherwise specified).
Distribution, wholesale and retail, not manufacturers who distribute direct.
Engineers, architects and accountants.
Medical industries (drugs and pharmaceutical chemicals, including medicinal chemicals, pharmaceutical chemicals, biological products, essential oils, plasters, dental supplies, surgical instruments).
Trade papers, magazines, newspapers and house organ editors.

A list of 25 questions has been sent out by the War Service Executive Committee to the members of all war service committees for use as a basis for their deliberations at their first meeting on Dec. 3.

To the members of the War Service Committees:

1. What legal methods or means could be introduced in your industry to better stabilize prices, during the Reconstruction Period, affected by the following:

a, Inventories on hand; b, orders placed at war prices but not delivered; c, labor costs and conditions; d, increased taxes; e, increased rates of interest; f, an estimated increased demand for non-war materials restricted during the war period; g, will an increased production of your commodity increase the price of material or labor, or will a controlled redistribution of material and labor from war industries prevent such an increase? h, discuss the practice of the sale of commodities at a price

less than the cost of production; its injury and disturbance on the industries and the ultimate consumer; what methods would you suggest to remedy this evil? i, if the Government sees fit to dispose of used materials and products in the open market, what effect will it have on your production and the sale of new goods—at home—abroad? j, if it is not advisable for the Government to sell these goods on hand, either home or abroad, what shall it do with them? k, in this connection, what point of contact should business interests have with the Governmental departments in the sale or disposition of these various commodities?

2. What is the estimated amount of labor, skilled and unskilled, male and female, required for the estimated 1919 production? What is to be the source of labor? How much must be moved? How much have you lost to war industries?

3. What is your financing problem during the Reconstruction Period? Do you recommend Governmental aid? Is financial legislation needed? Should the Capital Issues Committee be continued during this period?

In this connection discuss and recommend, what financial obligations, if any, the industries in your craft are under to the Government for moneys advanced for buildings, machinery or as loans or security for Government contracts. How are these to be liquidated or adjusted?

4. What method would you suggest for the cancellation of Government war orders with your craft, that would create the least amount of hardship on the industries and permit a readjustment to normal commercial conditions?

5. On undelivered Government orders, what percentage of materials on hand, supplied either by the Government or purchased by you for these Government orders, can be utilized by your craft for commercial purposes during 1919? What disposition shall be made of those not usable?

6. Have you any suggestions to make as to the continuation of the War Industries Board or any of its divisions, or any other Governmental departments during the period of Reconstruction? Such Board or departments to have the authority to control materials and regulate prices. If so, for what period?

7. What intelligent control of materials during the Reconstruction Period could the War Service Committee suggest which would prevent an over or under supply and avoid a demoralization of the market? Should this be controlled by the crafts or by a Governmental agency?

8. What effect had the war program on your output? Was it increased or decreased? Will there be an increased demand during the Reconstruction Period? If materials are uncontrolled, will prices go up or down?

9. What is the estimated tonnage or unit of production of your raw materials for 1918? For 1919? Estimated demand for foreign commerce for 1919?

10. What is the estimated demand for your finished product for 1919? How does this compare with the average demand per annum in weight or unit of production for a five-year period immediately prior to 1914?

11. Sources of your raw materials? Domestic or imported? If domestic, can railroad cross hauling be eliminated by purchasing nearer your plants? Causes of cross-hauling? If imported, at what ports? Would other ports of entry be more advantageous? What ports and why?

12. The value of a uniform method of cost accounting for the individual manufacturer and the craft as a whole.

13. What suggestions of the Conservation Division made to your craft might, with financial profit to your craft, be continued during the readjustment period? Is it possible to maintain a conservation schedule after the war, without legislative authority?

14. What methods and practices, other than those your craft has already introduced, would simplify production, save materials, eliminate wasteful practices, reduce the number of styles, without destroying individual creativeness?

15. What propaganda is necessary to educate the retailer and consumer to accept these eliminations and simplifications, and what plans might be arranged for better functioning with committees of jobbers and retailers handling your commodities?

16. What percentage of the commodities represented by your war service committee was produced in the United States before the war and what percentage imported? What suggestion have you to make for increased production for domestic and foreign commerce?

17. What effect will foreign competition have on your business? Will it increase or decrease your production?

18. What is the underlying reason for the importation of foreign-made goods—Prices? Styles? Label? Quality? Design? Or excess demand over domestic supply?

19. What disposition should be made by the government of her merchant marine?

20. What steps have you taken, or do you propose to take, for the entire craft to take advantage of the Webb-Pomerene Bill, which allows combination for foreign trade, or have you other plans? What do you suggest as the best means of financing foreign credits? What percentage of the foreign commerce heretofore controlled by Germany can your craft obtain and supply?

21. What study is necessary, and what suggestions have you to make, in order to determine what are the needs of our allied countries for rehabilitation, and how far can you supply both raw and finished materials until they have been rehabilitated?

22. Has your craft been solicited by, or are you soliciting, foreign countries to supply these materials for rehabilitation purposes? If solicited, does this come from the Allies, or from neutral or enemy countries?

23. Would you recommend the appointment of a committee of United States manufacturers to confer with similar committees from our Allies, to learn of their

plans for protecting industry during the reconstruction period? Also to obtain information regarding commodities and supplies needed by them and ourselves during this period?

24. When the demobilization of military forces takes place, how can these men best be returned to their former industrial pursuits, and how will it affect your labor situation?

In this connection, how closely should the conference work with the governmental bodies in the study of demobilization plans?

25. What suggestions have you to make to encourage and stimulate public work, such as the building of roads, pavements, water and sewer extension, the construction of public buildings, school houses, etc.? What effect will it have on the labor market?

In this connection consider the building program in the United States and especially the utilization or destruction of new plants built for war purposes. Location of convalescent and reconstruction hospitals near industrial centers so that these men can be trained in the factories nearest to the hospitals without creating new vocational schools.

Dec. 4 and 6 general morning sessions will be held, and sections meetings of related industries will be held on the 4th in the afternoon and evening, and the 5th, morning and afternoon.

With these groups will meet the commodity or section chiefs of the War Industries Board. Related groups will form themselves into ten major groups on the evening of Dec. 5, to take up the question of raw materials, price control and subjects arising from related group meetings. After the general meetings of the committees of the related groups and of the major groups it is hoped there will be presented at the general sessions on the 6th, definite recommendations covering the reconstruction period, with the possibility of creating an executive committee empowered to gather data and to function with industries to meet the many problems that the nation's industries will be called upon to solve with the end of the war.

In connection with cancellation of contracts, President Harry A. Wheeler, of the Chamber of Commerce of the United States, recently wrote to President Wilson urging, in behalf of the War Service Executive Committee, the creation of a Clearance Committee to which all proposals of cancellations be referred by the various government agencies. He pointed out that cancellations already made and consequent stoppage of work are creating alarm in the industries likely to be affected, and among banks which have financed them when undertaking government contracts.

Some means should be available for arranging as to redistribution of material released by cancellations, and for protecting manufacturers and employers against sudden stoppage of plants, and loss on investment made for special facilities to carry on government work. The means adopted, should, so far as possible, be uniform for all departments, and it is in these two phases of the matter that the Clearance Committee can be of great benefit.

It is to be hoped that such a committee may serve to hold industrial interests steady until some definite policy as suggested by the Reconstruction Conference can be worked out and put into force.

Men Wanted to Assist the Fuel Administration

THE BUREAU OF CONSERVATION of the United States Fuel Administration has classified engineers who can now be of assistance to it in consummating its plans for conserving 50,000,000 tons of coal annually, as follows:

Class 1—Engineer inspectors to call at plant, receive and check accuracy of the second copy of the questionnaire.

Class 2—Diplomatic engineers who may be detailed to special work, such as explanation of program and recommendations to plant owners who do not react quickly, who offer objections or who fail to understand, etc.

Class 3—Engineers capable of receiving, examining and marking questionnaires in local districts under the direction of the Administrative Engineer.

Class 4—Lecturers or public speakers.

Class 5—Inspectors to teach fuel conservation classes connected with universities, extension work or other educational enterprises.

Those who can spare the time, a few hours a week, will help, and are capable of performing any of the work mentioned above should volunteer their services to their respective administrative engineers. This work is a patriotic duty, the performing of which will give nearly every worker a broader conception of power plant practice.

Red Cross Work in the Front Line

WHEREVER the American soldier goes, the Red Cross goes with him. From the day he enters the service, in camp and troop train, transport and trench, until the day when peace is declared and he is mustered out, the Red Cross looks after his physical and mental comfort, cares for him when he is sick, follows him into battle, looks after his family at home. Perhaps there is less romance in the work at home among the families of the boys over there, though the Home Service workers will not tell you so. But there can be no doubt of the interest and excitement of the work in the front line, cruelly hard and wearisome and dangerous as it always is.

The front service men at the Red Cross outposts get little rest. Hot drinks and smokes, chocolate and post cards and writing paper are always ready for distribution to the men coming off duty. During the operations of the soldiers, when an offensive started the Red Cross man loaded himself up with cigarettes, chocolate, bandages and drink, and followed the boys out across No

Man's Land through the rain of shell splinters and machine gun bullets. As they pushed on toward their objectives he followed them—running, crawling, taking shelter in shell holes, passing out his comforts to the wounded and to the hot and weary soldiers who had paused for a time in their advance.

At such times the Red Cross men performed all duties that were immediately necessary. They acted as ambulance drivers, stretcher bearers, couriers, surgeons' assistants, even staff officers. Wherever the work was hottest you found them doing whatever they found to do, and doing it with all that was in them.

In the accompanying photograph are shown wounded American soldiers coming in camions from the Paris hospitals to the *Cafe des Ambassadeurs* for refreshments and entertainment given them by the American Red Cross on the Fourth of July, 1918.

Until America declared war, the Red Cross had many ambulances on the Western Front; but in the fall of 1917, all these were taken over by the United States Army. In Italy, however, American Red Cross ambulances remained operating, and a number of decorations, and many citations, have been won by the bravery and self-sacrifice of their drivers. Back and forth between the first aid stations and the hospitals they went, through the hell of Austrian shrapnel and gas and high explosive, driving at night at high speed over shell wrecked roads without lights, working without rest for days on end. And the Italians, like our own boys, like the people of France and Belgium and Serbia and Rumania and Palestine, have nothing but good to say of the Red Cross—and of the hundred million Americans behind the Red Cross.

WOUNDED AMERICAN SOLDIERS

For although the membership of the Red Cross is only about one-fifth of the population of the United States—twenty-two million—yet it cannot be questioned that every American citizen is heart and soul in sympathy with the Red Cross ideal. It is to give concrete expression to that sympathy—to give notice to the world that every man, woman and child in America is squarely back of the Red Cross—that the Christmas Roll Call will be held in the week beginning Dec. 16.

During that week everyone will be given the chance to add the weight of his name to the Red Cross message. Let us answer with one voice to the word of President Wilson, when he says: "I summon you to the comradship."

The Navy's Job is Just Half Done

EVERY soldier who sailed for France was given a round-trip ticket. The Navy took them over and now the Navy must bring them back. There can be no relaxation of effort until the job is done, until every one of our boys is returned to his home. To complete this task the Navy needs more men, and the need is just as urgent now as it was before the armistice was signed. This condition offers you an opportunity to be identified with the Great War, your LAST CHANCE.

The cancellation of the November draft call has deprived thousands of men of the privilege of participating in the war, but the Navy's call for men enables you to volunteer your services. If you can qualify for any of the vacancies now existing you may be inducted into the service at once.

Men are needed now, not to fight, but for services equally essential to the re-establishment of normal conditions. The Bureau of Navigation has issued a call for several hundred men who can qualify for posts which require specialized ability. Only those men who are registrants of Sept. 12, 1918, or registrants of deferred classifications of previous registrations are eligible. Applications will now be received for training in the Engineer Officer School. Applicants must be high-school graduates and graduates of an engineering course at a recognized technical school, or of equivalent training. The age limit is 21 to 40 yr., inclusive.

Further information and full particulars will be furnished upon application at the U. S. Navy Mobilization Station, in the Transportation Bldg., Chicago. Mail should be addressed to Lieut. H. D. Childs (Rt'd), Commanding Officer.

News Notes

STOKER manufacturers have organized an association, the chief object being to place at the disposal of the government their entire facilities to help out in the fuel emergency. The war service committee of the association is working with the Fuel Administration and the War Industries Board on questions of fuel, raw material and labor. Officers elected were: President, P. Albert Poppenhusen, Chicago; vice-president, S. L. Nicholson, East Pittsburgh; secretary-treasurer, Fred H. Daniels, Worcester. Directors: William F. Santer, Philadelphia, and W. H. Rea, Detroit.

APROPOS of the movement for the conservation of fuel is the announcement of a motion picture entitled, "Coal is King," produced by the Ford Motor Co. This picture, taken under the direction of and from scenario by Robert June, mechanical engineer, Diamond Power Specialty Co., Detroit, Mich., treats the situation in a very thorough manner.

Good and bad methods of coal mining transportation are shown. Good and bad methods of firing, losses from leaky steam pipes, uncovered pipes, leaky steam traps, and the use of CO_2 records are brought in clearly. In fact, everything pertaining to boiler room practice has been pictured.

The necessity for keeping the boiler surface clean is properly brought out. Pictures of scale and soot removal are shown, losses caused by firing the boiler too high or too low above or below rating, losses caused by cutting in stand-by boilers too early or too late, losses caused by uncovered steam pipes, leaky pipes, steam traps, etc.

The Ford Motor Co. offers this picture to organizations such as the Chamber of Commerce, A. S. M. E. or N. A. S. E., for exhibition to power plant operators. Much good can come from seeing it, and there should be a ready response to this offer. At present a great many dates of exhibition have been closed, several states having been booked solid.

All communications relative to date of exhibition are to be addressed to Robert June, at the Diamond Power Specialty Co., Detroit, who is supervising the distribution for the Ford Co.

THE OHIO BRASS CO. announces the removal of its New York office from 30 Church St. to 1781 Hudson Terminal Building, 50 Church St.

THE BOUND BROOK OIL-LESS BEARING CO., Bound Brook, N. J., announces the appointment of E. L. Evans as superintendent of the company's plant No. 1. He was former chief inspector of this plant.

G. A. BINZ, sales manager Yarnall-Waring Co., Philadelphia, has transferred his headquarters to the company's New York office at 90 West St., and will in future devote his whole time to the interests of "Yarway" specialties in that area.

U. S. CIVIL SERVICE COMMISSION announces examinations for ship draftsman, and architectural, mechanical, and structural-steel draftsman for ship work, for both men and women. Vacancies in the Navy Department, Washington, D. C., and in the Navy Yard Service throughout the United States will be filled from these examinations. This announcement cancels announcement No. 2206—Amended, of the continuous, nonassembled examination for architectural, mechanical, and structural-steel draftsman, for the Navy Department and Navy Yard Service. As there is an ample register of architectural and structural-steel draftsmen who are not willing to accept employment on ship work, applications under this announcement will be received only from persons who express willingness to accept employment in the Navy Department or in the Navy Yard Service on ship work. Until further notice, applications will be received at any time. Papers will be examined immediately upon their receipt by the commission, and a grade and a rating in that grade will be assigned the competitor. Those who are found qualified will be offered employment at once. In view of the needs of the service, and until further notice, subjects of countries allied with the United States will be admitted to this examination, provided they are otherwise qualified. Such persons may not be certified for appointment, however, so long as there are United States citizens on the eligible list. Apply for Form 1312, stating the title of the examination desired, to the Civil Service Commission, Washington, D. C.

AT THE ANNUAL MEETING of the A. S. M. E., 29 West 39th St., New York City, Dec. 3-6, several matters of special interest to power-plant engineers will be considered. At the morning session, Dec. 4, the Committee on Standardization of Pipe Flanges and Fittings will present its report, which will be discussed and acted upon. In the afternoon, at the refrigeration session, V. J. Azbe will present a paper on Refrigerating Plant Efficiency, and there will be topical discussion on Fuel Economy in Refrigerating Plants.

The afternoon of Dec. 5, a gas power session will be held, with papers by C. A. Norman on Cooling Losses in Combustion Engines, and by J. W. Anderson on Problems in Regard to Marine Diesel Engines.

Friday morning, Dec. 6, at the power plant session, papers will be read by G. D. Bagley on Heat Losses from Pipes and Boilers, and by E. A. Uehling on Chemical and Physical Control of Boiler Operation.

All engineers are welcome to the meetings.

NEW RULINGS of the War Trade Board in connection with sending of parcels to American soldiers abroad require that in order to send any parcel, a written signed request must be received from the soldier for the article, and must have been approved by the regimental or higher commander. This request must be enclosed with the parcel, which can then be shipped by parcel post under the general export license No. RAC-43 issued to the Postoffice Department.

Each parcel so shipped must have on the wrapper, "Shipped under export license No. RAC-43;" statement of contents; name and address of shipper; name and address of consignee; "This parcel contains only articles sent at approved request of addressee, which is enclosed."

No shipment can be made in this way to prisoners of war or interned persons.

AS AN AID to encouraging trade of the United States with Belgium, the American-Belgian Chamber of Commerce has been formed in London, and its headquarters will be transferred to Brussels as soon as that city is evacuated. Directors are from the most prominent American firms, and the object is solely to aid American manufacturers in trade relations with Belgium. Belgium will require a vast amount of material for rebuilding railways, public buildings, factories and dwellings, as well as equipment and supplies for industries and households. She will look to the United States to supply a large part of this, and every exporter or manufacturer who seeks that trade will benefit by membership in the American-Belgian Chamber of Commerce. Application forms may be had from the secretary, 110 Cannon St., London E. C. 4, England, or from the London office of Dry Goods Economist, 11 Queen Victoria St., E. C. 4.